TRANSACTIONS AND PROCEEDINGS

OF THE

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VOLUME XXX.

PART III.

SESSION 1929–30.

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PROCEEDINGS

OF THE

BOTANICAL SOCIETY OF EDINBURGH.

SESSION XCIV

OCTOBER 24, 1929.

SYMINGTON GRIEVE, Esq., Vice-President, in the Chair.

The following Office-Bearers were elected for Session 1929–1930:—

PRESIDENT.

J. RUTHERFORD HILL, Ph.C.

VICE-PRESIDENTS.

W. EDGAR EVANS, B.Sc., F.R.S.E.
Sir EVERARD IM THURN, K.C.M.G., K.B.E.
Professor R. A. ROBERTSON, M.A., B.Sc., F.R.S.E.
HARRY GEO. YOUNGER, Esq.

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J. A. TERRAS, B.Sc.
MALCOLM WILSON, D.Sc., F.L.S., F.R.S.E.

Honorary Secretary—J. R. MATTHEWS, M.A., F.L.S., F.R.S.E.
Foreign Secretary—Professor W. WRIGHT SMITH, M.A., F.R.S.E.
Treasurer—ANDREW MASON, Esq.
Assistant-Secretary—J. T. JOHNSTONE, M.A., B.Sc.
Artist—R. M. ADAM.
Auditor—WILLIAM C. CALLENDER.

Mrs KATE R. TERRAS was elected an Ordinary Fellow.

The Chairman announced the death, on 12th July, of the Rev. Dr. PAUL, who had been Hon. Foreign Secretary since 1906, and was President for sessions 1899–1901 (see p. 183).

Mr. GEORGE FORREST delivered an address on the Peoples and Customs of Yunnan, illustrated by a series of lantern slides. These included a number showing flowers of the country in their natural colours.

NOVEMBER 21, 1929.

J. RUTHERFORD HILL, Ph.C., President, in the Chair.

The PRESIDENT intimated that the Council had received the resignation of Mr. J. R. MATTHEWS as Hon. Secretary in consequence of his having been appointed to the Chair of Botany at Reading University.

Dr. R. J. D. GRAHAM was elected Hon. Secretary.

The TREASURER, Mr. ANDREW MASON, submitted the following Statement of Accounts for Session 1928–1929 :—

INCOME.

Annual Subscriptions for 1928–1929	£56	10	0
Do. Arrears	4	15	0
Transfer from Life Members' Fund	20	19	0
Transactions sold	9	8	6
Interest on Funds Invested and in Bank	15	2	1
Subscriptions to Publications Fund	16	8	0
Income from Botanical Society Trust Fund	17	14	8
	£140	17	3

EXPENDITURE.

Printing *Transactions* for Session 1927–1928	£58	3	11
Printing and Postage of Notices for Meetings, etc.	21	9	9
Rooms for Meetings and Tea	7	7	0
Stationery, Postages, Advertising, etc.	5	7	6
Fire Insurance on Books, etc.	0	5	0
Honorarium to Treasurer	3	3	0
	£95	16	2
Excess of Income	£45	1	1

STATE OF FUNDS.

Life Members' Fund.

Balance of Fund at close of Session 1927–1928 . .		£263 10 0
Add—Life composition received		*nil*
		£263 10 0
Deduct—Transferred to Income		20 19 0
Balance as at close of Session . .		£242 11 0

Ordinary Fund.

Balance of Fund at close of Session 1927–1928	£105 1 9	
Add—Increase during Session 1928–1929	45 1 1	
Balance as at close of Session, subject to expense of printing *Transactions*		150 2 10
Total Funds . .		£392 13 10
Being:—£200 5% War Stock, 1929–1947, at cost	£194 18 3	
Sum in Current Account with Union Bank of Scotland, Ltd. .	8 10 7	
Sum in Deposit Receipt with do.	190 0 0	
Due by Treasurer . . .	0 5 0	
	£393 13 10	
Less—Subscription received in advance	1 0 0	
As above .		£392 13 10

Note.—Subscriptions in arrear, considered recoverable: 1927–28, £1; 1928–29, £6.

EDINBURGH, *5th November* 1929.—I hereby certify that I have audited the Accounts of the Treasurer of the Botanical Society of Edinburgh for Session 1928–1929, and have found them correct. I have also checked the foregoing Abstract, and find it correct. I have seen the securities for the invested funds and have found them in order.

W. C. CALLENDER, *Auditor.*

BOTANICAL SOCIETY TRUST FUND.

INCOME.

Interest on Funds invested	£17 14 8

EXPENDITURE.

To Publications Fund	£17 14 8

EDINBURGH, *14th October* 1929.—I have examined the books and vouchers of the Edinburgh Botanical Society Trust Fund, and certify the same to be correct.

ROBERT L. GORRIE.

Mr. ALEXANDER B. BROWN and Miss F. B. MURRAY were elected Ordinary Fellows.

Miss EVA STUART WATT was elected a Lady Member.

Mr. E. WYLLIE FENTON read a paper entitled a Botanical Study of some Scottish Grasslands.

The following plants in flower were shown from the Royal Botanic Garden: *Aeschynanthus bracteata* Wall.; *Bignonia buccinatoria* Mairet; *Callicarpa purpurea* Juss.; *Cuscuta reflexa* Roxb.; *Dichorisandra thyrsiflora* Mikan; *Erica grandiflora* Linn. f.; *Fuchsia bacillaris* Lindl.; *Iochroma tubulosa* Benth.; *Masdevallia laucheana* Kraenz.; *Mutisia retusa* Remy var. *glaberrima*; *Nerine Bowdenii* W. Watson, *N. candida* Hort.; *Odontoglossum McNabianum* ×; *Pleione maculata* Lindl. et Paxt.; *Polygala Chamaebuxus* varr. *grandiflora* and *lutea*; *Primula calciphila* Hutch.; *Rhipidoglossum rutilum* Schlechter; *Rhipsalis gracilis* N. E. Br. and *Streptocarpus Holstii* Engl.

DECEMBER 19, 1929.

J. Rutherford Hill, Ph.C., President, in the Chair.

Mr. R. G. Heddle was elected an Ordinary Fellow.

Mr. H. B. Gilliland, Mr. H. A. Weber, and Mr. W. Handyside were elected Ordinary Members.

Mr. R. M. Adam made the following motion:—

"That this Society views with the gravest concern the threat to the Natural Scots Pine Forest caused by the Grampian Electricity Supply Bill, which is seeking powers to harness the waters of Glen Affric and Glen Cannich in the counties of Inverness-shire and Ross-shire.

"In both Glens there are tracts of Natural Scots Pine Forest which have important interests for the naturalist, more particularly the forester.

"The works projected by the 'Bill' threaten to destroy by submergence part of the old wood, while a ruthless destruction is likely to be the fate of the old specimen trees which form a belt above the water level.

"It is urged that in view of these facts this Society take action and in the fullest measure bring pressure to bear on those who have the scheme in contemplation—seeking to make it imperative that as far as the measure will allow every possible means be taken to secure the preservation of the natural woodlands in either Glen."

The PRESIDENT seconded the motion and Dr. SUTHERLAND spoke in support of it, and it was carried unanimously.

Mrs. N. L. ALCOCK gave an account of the places visited by her when with the British Association in South Africa, and illustrated her account with numerous lantern slides.

There were exhibited from the Royal Botanic Garden a large number of South African plants, some of which were in flower.

JANUARY 23, 1930.

J. RUTHERFORD HILL, Ph.C., President, in the Chair.

The Chairman announced the death of Mr. A. D. RICHARDSON, who had been an Associate since 1883.

Dr. J. W. GREGOR read a paper on Growth Forms within the Sea Plantain (*Plantago maritima* Linn.), which he illustrated with lantern slides.

Mr. J. H. WHYTE read a paper on the Recognition of some Agricultural Grasses by their Vegetative Characters (see p. 206).

Mr. SYMINGTON GRIEVE exhibited a spirally-twisted stem of Canadian Poplar.

The following plants in flower were exhibited from the Royal Botanic Garden: *Acacia Balfouriana* Woodr.; *Angraecum maxillarioides* Ridl.; *Crassula alpestris* Linn. f.; *Daedalacanthus nervosus* J. Anders.; *Dendrobium Chalmersii* F. Muell., *D. cymbidioides* Lindl., *D. subclausum* Rolfe; *Eria globifera* Rolfe, *E. lobata* Reichb. f.; *Peliosanthes humilis* Andr.; *Primula effusa* W. W. Sm. et Forrest, *P. malacoides* Franch.; *Sedum compressum* Rose and *Whitfieldia lateritia* Hook.

FEBRUARY 20, 1930.

J. RUTHERFORD HILL, Ph.C., President, in the Chair.

Mr. IVAN M. LAMB, Mr. D. MARSHALL, and Mr. J. RANKIN, junr., were elected as Ordinary Members.

Mr. R. M. ADAM gave an address on the Selection of a Site for a Scottish National Park. He first enumerated the considerations to be kept in mind when selecting a site and then considered the claims of several localities, laying greatest stress on Glen Affric. He showed a large number of lantern slides illustrative of the various possible sites (see p. 187).

The following plants in flower were shown from the Royal Botanic Garden: *Begonia laciniata* Roxb. ♂ and ♀; *Bulbophyllum comosum* Hemsl.; *Coelogyne intermedia* × ; *Cotyledon fulgens* Baker; *Cymbidium Wilsoni* Rolfe; *Illicium floridanum* Ellis; *Laelia harpophylla* × Reichb. f.; *Loropetalum chinense* Oliv.; *Magnolia denudata* Desr.; *Masdevallia Schroederiana* Sander; *Oncidium Cebolleta* Sw.; *Ornithidium densum* Reichb. f.; *Platyclinis glumacea* Benth.; *Rhododendron argenteum* Hook. f., *Rh. irroratum* Franch. and *Rh. moupinense* Franch.

MARCH 20, 1930.

SYMINGTON GRIEVE, Esq., in the Chair.

Mr. ERIC DRABBLE communicated a paper entitled a List of Scottish Pansies (see p. 190).

Dr. MALCOLM WILSON read a paper on a Disease of Spruce Cones caused by *Ascochyta piniperda*, and illustrated it with lantern slides.

Miss M. H. SMITH read a paper on Leaf Anatomy of the British Heaths, and illustrated it with specimens and lantern slides (see p. 198).

Mr. L. B. STEWART exhibited specimens of Elm showing old pruning, and also haustoria of *Cuscuta reflexa* showing vegetative growth.

The following plants in flower were shown from the Royal Botanic Garden: *Aeridovanda Mundyi* × ; *Arpophyllum giganteum* Hartw.; *Blaeria spicata* Hochst.; *Camellia reticulata* Lindl.; *Crassula barbata* Linn f.; *Dendrobium delicatum* Bailey; *Erica campanulata* Andr., *E. laevis* Andr., *E. speciosa* Andr.; *Kalanchoe Dyeri* N. E. Br.; *Lycaste Lucianii superba* ×, *L. plana* Lindl. (Temple's var.), *L. Skinneri* Lindl. var. *alba*; *Morisia hypogaea* J. Gay; *Physosiphon Moorei* Rolfe; *Scilla verna* Huds. and *Soldanella montana* Willd. var. *hungarica*.

APRIL 24, 1930.

J. Rutherford Hill, Ph.C., President, in the Chair.

Mrs. Menie Watt was elected an Ordinary Fellow.

Mr. Thomas Robson was elected an Ordinary Member.

Mr. J. H. Whyte read a paper on Bracken Sporelings (see p. 209).

Dr. R. J. D. Graham read a paper by himself and Mr. L. B. Stewart on Experiments with Vita Glass (see p. 212).

MAY 15, 1930.

J. Rutherford Hill, Ph.C., President, in the Chair.

Mr. L. B. Stewart read a paper by Dr. R. J. D. Graham and himself on Vegetative Propagation of Broccoli, which he illustrated with specimens (see p. 216).

Miss Lucy Boyd read a paper on Development and Anatomy of Monocotylous Seedlings—1. *Paris*; 2. *Costus*—which she illustrated with diagrams and specimens (see p. 218).

Sir Everard im Thurn exhibited some fasciated Tulips.

JUNE 19, 1930.

J. RUTHERFORD HILL, Ph.C., President, in the Chair.

Miss E. PHILIP SMITH read a paper on Flower Colours as Natural Indicators (see p. 230).

Professor J. R. MATTHEWS communicated a paper on Galloway Roses (see p. 239).

Mr. C. E. FOISTER exhibited a rare parasitic fungus on *Myrica Gale* (see p. 244).

Miss MOIR exhibited and explained a twenty-four-hour chart of the Circumnutation of *Helianthus tuberosus*.

TRANSACTIONS

OF THE

BOTANICAL SOCIETY OF EDINBURGH

SESSION XCIV

Glen Affric. By Robert Moyes Adam. (With Pl. XIV.)

(Read 20th February 1930.)

The movement set afoot to establish in Scotland a National Park has brought forward many places and scenes as favourable sites. If the main object of the park be to afford recreative facilities, it is desirable to have the place readily accessible to the masses. Should a National Domain be selected to form a "Reserve" open to the public yet with protection to fauna and flora as its main concern, remoteness might be considered an advantage.

It would be well to have in the site a landscape which will furnish the greatest topographical variety, with water and tracts of highly elevated ground intersected by valleys holding natural woodlands, features which in the fullest measure are characteristic of Scotland, and able to provide an environment for her indigenous plants and animals.

Glen Affric appears to fulfil these requirements, and offers an attractive sitė. Situated in the heart of Inverness-shire, Affric is the southernmost of three parallel valleys which run slightly south-west and west towards the north-east, and drain their waters respectively into Strath Glass, and ultimately unite to reach the Beauly Firth as the river bearing

that name. Glens Cannich and Strathfarrar, the other glens, have considerable charm, and have much in common with Glen Affric; and were the territory embraced by these three glens chosen as a "park" Scottish naturalists would have reason to rejoice.

Glen Affric perhaps ranks first in point of interest. Entrance to the glen is gained at Fasnakyle through a deep defile—the "Chisholm's Pass," a scene that can have few rivals in Scotland for rugged grandeur—where light and airy birch woods clothe the craggy slopes on all sides except on the south, and there a remnant of Scots pine forest introduces a sombre tone. Far beneath the road ascending the pass the River Affric tumbles restlessly over a rocky bed in a gorge flanked by precipitous sides.

Beyond the defile the valley widens, and thereafter for about three miles birch and pine intermingle. Among their number some hoary giant pines stand with stems exceeding 12 feet in girth. On the skyline rises the imposing summit of Sgurr na Lapaich, over 3400 feet—a feature which gives a Swiss touch to the landscape. Loch Beinn a' Mheadhoin is the first of a chain of lochs which lie in the glen, and are linked by the Affric—in character reminiscent of a scene in the backwoods of Canada, the big pines coming right down to the water's edge.

The loch extends for three miles, and is of the highland type—no marginal vegetation, but in places fringed by white sand shores. Westwards a short deep channel connects with a small loch—Loch an Laghair, "the loch of the shoe." This in turn forms a further narrow channel, which after rapids and broken water becomes the long sinuous eastern extremity of Loch Affric itself.

The setting of this loch is unique and is the most picturesque of the series, and unsurpassed by any similar scene in Scotland. The loch measures over four miles in length, and big hills rise steeply from the north and south shores. Mam Sodhail, over 3800 feet, towers above all to the north, and forms the central peak of the big group of summits which separate Glen Affric from Glen Cannich.

On the slopes which descend on the south shores of all the lochs a remarkable remnant of old Caledonian Forest pines still flourish, but on the north slopes the forest is represented

Loch Affric from the east.

Robert Moyes Adam.

by isolated trees. Tradition has it that this part was fired during some ancient clan feud, and to-day confirms the tale in the charred stumps that appear in places on the hillside. At no point does forest rise above 1600 feet, but in peat holes above 2000 feet the skeletons of former trees are frequently met with.

Glen Affric extends beyond the loch and becomes bare. The forest ceases and green slopes take its place—this is the region of high rainfall. The mountain panorama from this point is impressive—the jagged peaks of the Kintail hills, with alpine effect, occupy the western horizon. The farthermost reach of the glen is but a few miles from the western sea and terminates at the watershed, a glen that covers nearly twenty-five miles from end to end.

For the naturalist the glen has unique interests. The flora is attractive, the region having suffered slight interference from man; indeed, history shows that during the last two centuries the glen was used more for hunting than for crofting.

The pine forest is the outstanding feature in the glen, and provides a rare example of the real old Caledonian Forest. The possession of such a tract is of the highest importance and will present to the botanist and zoologist a storehouse for study. The valley flora is characteristic of the highland districts, where few of the plant immigrants associated with cultivation are found. The mountain regions have a poorer representation of arctic alpine species than in the rich districts of Central Perth and Forfar, but among their number are a few absent from the latter.

For fauna the whole presents a natural sanctuary where even at present a remarkable host of animals, typical of Scottish wild life, live with little interference.

The Glen indeed is a bit of unspoiled Scotland, and in any National Park project could conserve in their wild state a truly representative group of Scotland's animals and plants, while preserving in all its glory one of her most beautiful glens.

A List of Scottish Pansies.

By Eric Drabble, D.Sc., F.L.S.

(Read 20th March 1930.)

During the past twenty years many pansies from various parts of Scotland have been sent to me for examination and identification and it has been suggested that the results of my work are of sufficient interest to justify the publication of a list of some of the determinations.

For material I am particularly grateful to the late Rev. E. S. Marshall, who often visited Perthshire and other parts of the country and was in the habit of sending me very fine representatives of his gatherings.

To Mr. W. H. Beeby, Dr. G. C. Druce, Miss I. M. Hayward, Colonel H. Halcro Johnston and Professor J. R. Matthews I owe a debt of thanks for much interesting material; I have also named for Mrs. M. Corstorphine a very long series of gatherings from Forfarshire. The sheets in the Herbaria at the British Museum and at Kew have been examined.

It must clearly be understood that the naming of the plants listed below is entirely my own work. The name of the *collector* has been given in brackets where a note of this has accompanied the specimen.

The gatherings range widely over Scotland, but Clackmannan, Dumbarton, Linlithgow and Peebles are still without records.

Dumfriesshire (72).

V. segetalis Jord.—Dumfries (Herb. H. E. Wilkinson).

V. ruralis Jord.—Moffat (S. A. Naylor).

V. lutea Huds.—Moffat (S. A. Naylor); Wanlockhead, Sanquhar.

Kirkcudbrightshire (73).

V. segetalis Jord.—Gatehouse (D. Oliver).

Wigtownshire (74).

V. segetalis Jord.—Drummore, Wigtown.

V. lutea Huds.—Glen Cree.

AYRSHIRE (75).

V. lutea Huds. f. *Pesneaui* (*V. Pesneaui* Lloyd et Foucaud).—Stevenston, and between Troon and Dundonald (R. Mackechnie).

RENFREWSHIRE (76).

V. segetalis Jord.—Loganswell (R. Mackechnie).

V. variata Jord.—Bute (J. D. Hooker, 1867).

LANARKSHIRE (77).

V. lutea Huds.—Cathkin Braes (R. M'Kay); Glasgow.

V. lutea Huds. f. *amoena* Henslow.—Cathkin Braes (R. M'Kay); Strathaven (H. E. Fox).

SELKIRKSHIRE (79).

V. segetalis Jord.—Galashiels, Selkirk (I. M. Hayward).

V. Déséglisei Jord.—Galashiels (I. M. Hayward).

V. contempti Jord.—Selkirk (G. C. Druce).

V. Lloydii Jord.—Galashiels (I. M. Hayward).

V. Lejeunei Jord.—Selkirk.

V. variata Jord. var. *sulphurea* Drabble.—Lindean Pebbles, Selkirk (I. M. Hayward).

V. alpestris Jord.—Galashiels (I. M. Hayward).

V. monticola Jord.—Lindean Pebbles, Tweedside, Galashiels (I. M. Hayward).

V. lutea Huds.—Bowhill, Faldonside (E. S. Marshall); Clovenfords, Ettrick Bridge near Selkirk (I. M. Hayward).

ROXBURGHSHIRE (80).

V. segetalis Jord.—Lindean (I. M. Hayward); Melrose.

V. Déséglisei Jord.—Kelso.

V. monticola Jord.—Abbotsford, Lower Faldonside, Smailholm (I. M. Hayward).

V. alpestris Jord.—Abbotsford (W. A. Sledge).

V. lepida Jord.—Yetholm (I. M. Hayward).

V. lutea Huds.—Abbotsford (1870).

BERWICKSHIRE (81).

V. Déséglisei Jord.—Berwick.

V. ruralis Jord.—Berwick.

V. lutea Huds.—Yarrow Haugh.

V. lutea Huds. f. *calaminaria* (Lej.).—Lauder (I. M. Hayward).

HADDINGTONSHIRE (82).

V. ruralis Jord.—North Berwick Law.

EDINBURGH (83).

V. arvatica Jord.—Swanston near Edinburgh (1857).

V. lutea Huds.—Dalmahoy (G. Lloyd, 1825); Blackford Hill near Edinburgh, Pentland Hills.

FIFESHIRE (85 in part).

V. segetalis Jord. f. *obtusifolia* (Jord.).—Kilmeny.

V. Déséglisei Jord.—Tayport (C. H. Murray).

V. Lloydii Jord.—Cleish.

V. lutea Huds.—South Lethan[illegible] (J. H. Balfour, 1825); Dunearn Hill.

V. lutea Huds. f. *Curtisii* (Forster).—Tayport (C. H. Murray).

KINROSS-SHIRE (85 in part).

V. lutea Huds.—Ochil Hills (J. R. Matthews).

STIRLINGSHIRE (86).

V. lutea Huds.—Callander (Miss Prescott).

PERTHSHIRE (87, 88, 89).

V. derelicta Jord.—Lochay, Killin.

V. variata Jord.—Menteith (E. S. Todd).

V. lepida Jord.—Glen Lochan (R. J. Burdon); Loch Rannoch (A. Wilson and J. A. Wheldon); Glen Lochay, Glen Spean.

V. lutea Huds.—Glen Isla, Loch Rannoch, Glen Turrit, Breadalbane, Fortingal, Glen Ardle, Craig Caillaich, Glen Lyon, Glen Farg (Ochils), Glen Carness, etc.

V. lutea Huds. f. *amoena* Henslow.—Loch Tummel, Ben Lawers, Killin, Sow of Athol, Dalnaspidal, Glen Isla, Glen Shee, etc.

—— f. *insignis* (subvar. *insignis* E. G. Baker).—Craig Caillaich (J. Helsby).

V. lutea Huds. f. *Murrayi* Drabble.—Bank of the Spey.

V. lutea Huds. f. *sudetica* Willd.—Killin (P. Ewing).

(*V. lutea* and f. *amoena* have been sent to me from Perthshire by many collectors, amongst whom may be mentioned G. C. Druce, E. S. Marshall, J. R. Matthews, C. H. Murray and C. E. Salmon.)

ANGUS (FORFARSHIRE) (90).

V. agrestis Jord.—Forfar (G. C. Druce); Barry, Brechin, Bridge of Dun, Clova (Mrs. Corstorphine).

V. segetalis Jord.—Clova (G. C. Druce); Lunan (Mrs. Corstorphine).

V. segetalis Jord. f. *obtusifolia* (Jord.).—Monifieth (E. S. Todd); Arbroath (Mrs. Corstorphine).

V. Déséglisei Jord.—Auldbar, Barry, Brechin, Bridge of Dun, East Haven, Lunan Bay (Mrs. Corstorphine).

V. derelicta Jord.—Dundee, Invergowrie (C. H. Murray); Arbroath, Auldbar (Mrs. Corstorphine).

V. arvatica Jord.—Dundee (C. H. Murray); Clova (W. A. Sledge); Arbroath, Auldbar (Mrs. Corstorphine).

V. ruralis Jord.—Arbroath, Barry, Lunan Bay, Montrose (Mrs. Corstorphine).

V. latifolia Drabble.—Auldbar (Mrs. Corstorphine).

V. Lloydii Jord.—Balgavies (G. C. Druce); Bridge of Dun, Forfar (Mrs. Corstorphine).

V. Lejeunei Jord.—Balgavies (G. C. Druce); Arbroath (Mrs. Corstorphine).

V. variata Jord.—Arbroath, Carmylie Moor, Clocksbriggs, Clova, Colliston, Lunan Bay, Red Head, Rossie Moor (Mrs. Corstorphine).

V. variata Jord. var. *sulphurea* Drabble.—Lunan Bay, St. Vigeans (Mrs. Corstorphine).

V. monticola Jord.—Clova (Mrs. Corstorphine).

V. alpestris Jord.—Clova (Mrs. Corstorphine).

V. lepida Jord.—Dunninald, Forfar, Lunan Bay (G. C. Druce); Barry Links (R. Mackechnie); Monifieth (E. S. Todd); Dicty Moor, Lethane, Montrose, Red Head, Rossie Moor (Mrs. Corstorphine).

V. lutea Huds.—Canlochan (H. C. Watson); Clova (A. Croall, 1840); Deer Forest, Forfar (W. Gardiner, 1843); Braemar, Carmylie, Dundee, Glen Doll, Lorn Hill.

V. lutea Huds. f. *amoena* Henslow.—Canlochan (H. C. Watson); Clova (A. Croall); Arbroath (Mrs. Corstorphine); Braemar.

V. lutea Huds. f. *Curtisii* (Forster).—Auldbar, Lunan Bay (Mrs. Corstorphine).

KINCARDINESHIRE (91).

V. agrestis Jord.—Bervie (C. Bailey).

V. segetalis Jord. f. *obtusifolia* (Jord.).—Banchory (G. C. Druce).

V. Déséglisei Jord. f. *subtilis* (Jord.).—Bervie (C. Bailey); Banchory (G. C. Druce).

V. ruralis Jord.—Bervie (C. Bailey).

V. variata Jord.—Stonehaven (C. Bailey).

V. lepida Jord.—Banchory, St. Cyrus (G. C. Druce); Crossmichael (H. E. Fox); Stonehaven.

ABERDEENSHIRE (92, 93).

V. derelicta Jord.—Glen Muick (C. H. Murray).

V. Lejeunei Jord.—Alford (G. C. Druce).

V. variata Jord.—Kincardine (Aberdeenshire).

V. lepida Jord.—Ballater, Braemar (G. C. Druce); Glen Muick (C. H. Murray).

V. lutea Huds.—Craig Koynoch (W. Gardiner, 1845); Glen Muick, Kincardine O'Neil (C. H. Murray); Braemar.

V. lutea Huds. f. *amoena* Henslow.—Glen Muick, Kincardine O'Neil (C. H. Murray).

V. lutea Huds. f. *sudetica* (Willd.).—Ballater (H. H., 1847).

BANFFSHIRE (94).

V. derelicta Jord.—Inchrory, Glen Avon.

V. lutea Huds.—Tomintoul.

MORAYSHIRE (ELGIN) (95).

V. segetalis Jord. f. *obtusifolia* Jord.—Longmorn (K. D. Little).

V. variata Jord.—Longmorn (K. D. Little).

V. lepida Jord.—Forres (C. Bailey).

V. lutea Huds.—Dava.

INVERNESS-SHIRE (96, 97).

V. lepida Jord.—Glen Spean (E. S. Marshall).

V. lutea Huds.—Aviemore (C. E. Salmon); Kincraig (A. Somerville); Dalwhinnie, Fort Augustus, Glen Spean.

V. lutea Huds. f. *amoena* Henslow.—Arderikie Forest (W. A. Shoolbred).

V. lutea Huds. f. *Pesneaui* (Lloyd and Foucaud).—Glen Beg (A. Somerville).

ARGYLLSHIRE (98, 101).

V. Lejeunei Jord.—Dalmally (E. S. Marshall).
V. lepida Jord.—Dalmally (E. S. Marshall).
V. lutea Huds.—Benderloch.
V. lutea Huds. f. *Curtisii* Forster.—Ardnamurchan and Island of Coll (S. M. Macvicar); Ardlamont.

ARRAN (100).

V. agrestis Jord.—Arran (G. C. Druce).
V. segetalis Jord. f. *obtusifolia* (Jord.).—Brodick (W. G. Travis).
V. lutea Huds. f. *amoena* Henslow.—Machrie Bay (H. W. Daltry).
V. lutea Huds. f. *Curtisii* (Forster).—Brodick, Dromodune (W. G. Travis).

ROSS-SHIRE AND CROMARTY (105, 106).

V. segetalis Jord.—Strathcarron.
V. variata Jord.—Big Sand, Dingwall, Ullapool (G. C. Druce).
V. lepida Jord.—Achilty (E. S. Marshall and W. E. Shoolbred); Big Sand, Dundonnell (G. C. Druce).
V. lutea Huds. f. *Curtisii* (Forster).—Loch Carron.

SUTHERLAND (107, 108).

V. agrestis Jord.—Tongue (E. S. Marshall).
V. segetalis Jord.—Dornoch (R. S. Standen); Golspie.
V. derelicta Jord.—Melvich (E. S. Marshall).
V. Lejeunei Jord.—Melvich (E. S. Marshall, G. C. Druce).
V. orcadensis Drabble.—Melvich (E. S. Marshall).
V. variata Jord.—Invershin (G. C. Druce); Tongue (E. S. Marshall).
V. lepida Jord.—Altnaharra (G. C. Druce).
V. lutea Huds. f. *amoena* Henslow.—Durness (H. E. Fox); Inchnadamph.
V. lutea Huds. f. *Curtisii* (Forster).—Far-out Head (H. E. Fox); Golspie.

CAITHNESS (109).

V. Lejeunei Jord.—Thurso (G. C. Druce).
V. orcadensis Drabble.—Reay (W. F. Millar); Wick (E. S. Marshall).

V. variata Jord.—Island of Stroma (A. M. Geldart); Wick (E. S. Marshall).

V. lepida (Jord.).—Thurso, Wick (H. E. Fox).

V. lutea f. *Curtisii* (Forster).—Reay Links (W. F. Millar); Dunnet Links (C. E. Salmon); Sinclair Bay (J. Grant); Keiss Links.

Outer Hebrides (110).

V. lutea Huds.—Benbecula and Kirkibost Island, N. Uist (W. H. Beeby).

V. lutea Huds. f. *Curtisii* (Forster).—Barra and S. Uist (A. Somerville); Barve and Huishenish, Harris (G. C. Druce).

Orkney (111).

V. agrestis Jord.—Hurkisgarth, Mainland (H. H. Johnston).

V. derelicta Jord.—Loch Skaill (W. A. Shoolbred); Birsay, Firth, Stromness (H. H. Johnston).

V. Lloydii Jord.—Birsay, Orphir (H. H. Johnston).

V. Lloydii Jord. var. *insignis* Drabble.—Hoy, Stromness (H. H. Johnston).

V. Lejeunei Jord.—Loch Skaill (W. A. Shoolbred); Birsay, Cairston, Firth, Stromness, South Ronaldshay (H. H. Johnston).

V. variata Jord.—Quoy's Hoy (G. C. Druce); Cava, Deerness, Evil, Egilsay, Fara, Flota, Graemsay, Rendall, Shapinsay, Stromness, Stronsay, Testaquoy, Viera (H. H. Johnston).

V. orcadensis Drabble.—Kirkwall (W. R. Linton); Stronsay (— Gibbs); Birsay, Deerness, Fara, Hurkisgarth, Sandwick, Stronsay (H. H. Johnston).

V. lutea f. *Curtisii* (Forster) (including *Pesneaui*).—Banna Cross (Sanday), Evil, Saint Old, Stywick (Sanday) (H. H. Johnston).

Shetland (112).

V. derelicta Jord.—Dunrossness (W. H. Beeby).

V. Lejeunei Jord.—Fetlar (G. C. Druce).

V. orcadensis Drabble.—Baltasound, Sullom Voe (W. H. Beeby).

V. variata Jord.—Baliaster near Baltisound (W. H. Beeby); Barrafirth (Unst), Norwick (Unst) (G. C. Druce); Fetlar (H. H. Johnston).

V. lutea Huds.—Dalmahoy (Unst).
V. lutea Huds. f. *Curtisii* (Forster). –Fetlar (G. C. Druce).

(Many other records of pansies named by me from the Orkneys and Shetlands have been published by Colonel H. H. Johnston in the "Transactions of the Botanical Society of Edinburgh."

Leaf Anatomy of the British Heaths.

By Margaret H. Smith, B.Sc.

(Read 20th March 1930.)

This investigation of the British heaths was commenced with the object of determining the exact systematic position of the peculiar sport *Erica Crawfordii*. This heath was first found by Mr. F. C. Crawford, in 1901, during an excursion of the Scottish Alpine Botanical Club to Ireland, where it was growing on Craigga-More, near Roundstone, Galway, Connemara.

There has been much doubt in the past as to the systematic position of *Erica Crawfordii*. Neither Babington, Hooker, nor Hayward make any reference to this double variety. In Druce's British Plant List, 1928, it has been determined as a variety of *E. Tetralix*, but in the List of Trees and Shrubs grown in Kew Royal Botanic Garden it is recorded as a variety *flore pleno* of *Erica Mackayi*. Since Bentham and Hooker and Hayward regard *Erica Mackayi* itself as a variety of *Erica Tetralix*, *Erica Crawfordii* was classified by Professor Bayley Balfour in 1904, according to herbarium sheets, as *Erica Tetralix* var. *Mackayi*, forma *flore pleno*.

Thus it can be seen that the systematic position of *E. Crawfordii* involves the relations between *E. Tetralix* and *E. Mackayi*, since the latter has been variously placed. This has entailed an investigation for purposes of comparison into the three heaths mentioned, and also into certain other species allied to them. *E. Tetralix* and *E. Mackayi* come nearest to *E. Crawfordii* in systematic characters, the other species standing a good deal further away. The distinctions between *E. Mackayi* and *E. Tetralix* have been much discussed in the past. *E. Mackayi* was first found in Connemara, and Dr. Mackay, author of the Flora Hibernica, pointed out a resemblance to *E. ciliaris* in mode of growth and size. The identical heath was found in Truro, Cornwall, growing beside *E. ciliaris*. Hooker and Watson considered it to be a hybrid between *E. Tetralix* and *E. ciliaris*, because it seemed so completely intermediate in systematic characters between the two.

Consequently one would naturally expect to find *E. ciliaris* in Connemara. It has been found in Dorset, Cornwall, West France, Spain and Portugal, but never in Ireland.

Professor Macfarlane has already discussed the relations between *E. Mackayi* and *E. Tetralix*, and his argument appears in the "Transactions of the Botanical Society of Edinburgh." He and Sir J. Hooker came to the conclusion that *E. Mackayi* was not a hybrid but a well-marked variety or sub-species of *E. Tetralix*.

It seemed therefore that a more detailed examination of the leaf anatomy might serve not only to discriminate between *E. Tetralix* and *E. Mackayi*, but also solve the immediate problem of the relationship of *E. Crawfordii*.

In order to compare *E. Tetralix*, *E. Mackayi*, *E. Crawfordii*, and nearly allied species of heaths for their diagnostic characters, an analysis of each was made under two headings—(1) leaf characters, (2) leaf anatomy.

Erica Tetralix.

Leaf Characters.—Leaves petiolate 1 mm., linear-lanceolate $4\frac{1}{2}$ mm. $\times 1\frac{1}{2}$ mm., margins much incurved, exposing one-third of the under surface.

Lamina and petiole pubescent, leaf margins bearing two to three rows of glandular hairs.

Anatomy.—Upper epidermal cells small, tangentially elongated $36\,\mu \times 21{\cdot}5\,\mu$ approx., strongly cuticularised $10\,\mu$ in thickness.

Numerous simple unicellular hairs, either long with thin walls, or short with thicker walls.

Lower epidermal cells small, oblong, and less strongly cuticularised.

Stomata situated in the grooves of the rolled leaf, guard cells projecting above the level of the epidermis. Both glandular hairs, and simple hairs of two kinds, form a dense covering.

Glandular hairs are either (1) those of an unusual knuckle-bone shape, stalk two-celled, with a multicellular glandular head occurring on the under side of the leaf; or (2) long rigid hairs with a multicellular stalk and glandular head occurring on the leaf margins. Simple hairs either (1) short, curved,

papillate, occurring in the grooves, four to six arching over the stoma; or (2) long, straight, papillate, occurring on the mid-rib.

In all species examined the mesophyll is differentiated into palisade tissue of long narrow cells, occupying approximately the upper half of the leaf, and spongy tissue of loosely arranged cells, irregular in shape and size.

The bundle is large and more or less circular in outline, surrounded by a stereome, which is more developed on the upper and under sides of the bundle. A layer of parenchyma intervenes between the stereome and the lower epidermis.

The xylem vessels are relatively few, and small, forming a cluster.

Erica Mackayi.

Leaf Characters.—Leaves petiolate $\frac{1}{2}$ mm., oblong 3 mm. $\times$ $1\frac{1}{3}$ mm., margins revolute, exposing four-fifths of the under surface.

Lamina and petiole glabrous, except leaf margins which bear one row of large glandular hairs.

Anatomy.—Upper epidermal cells large, radially elongated 36 μ $\times$ 40 μ approx., cuticularised 8 μ in thickness. All the upper epidermal cells with rare exceptions show a clear transverse septum, dividing the cell into two approximately equal parts.

Lower epidermal cells small, oblong, and cuticularised. Guard cells of stomata project above the level of the epidermis.

Simple, short, curved, papillate hairs occur on under surface, two to four arching over the stoma. No hairs on mid-rib.

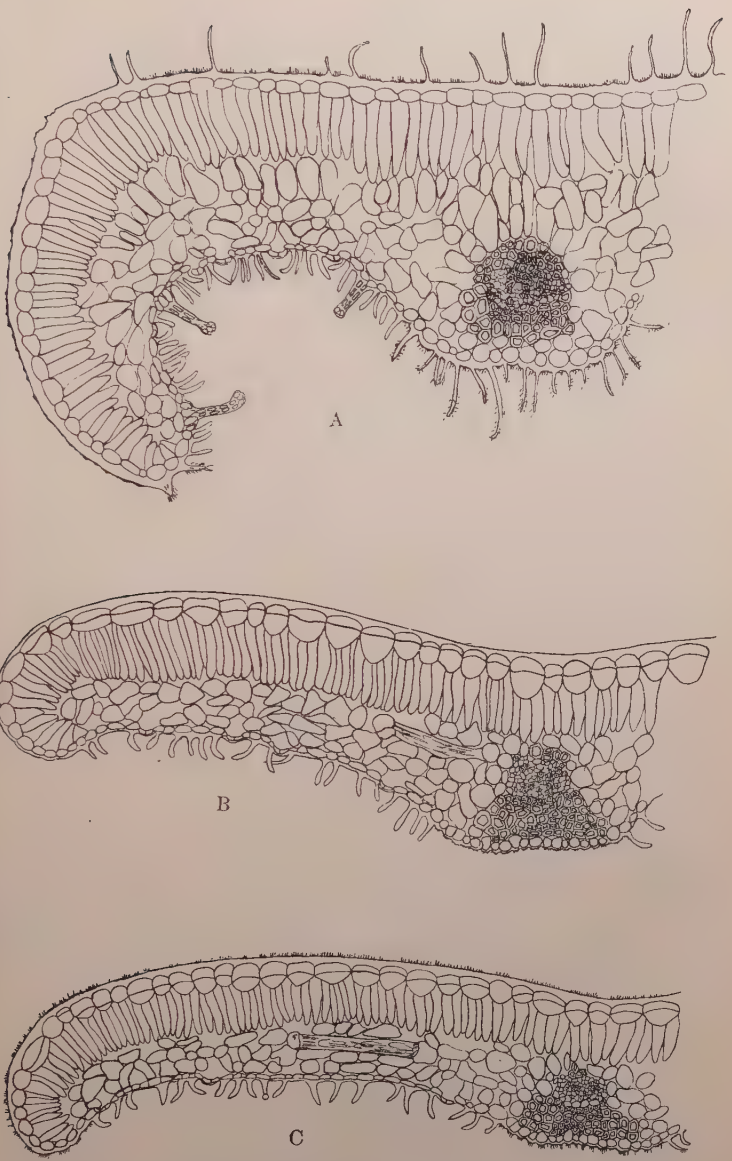
The bundle is large and triangular in outline, the base being parallel to the lower epidermis. The stereome consists of a small patch of cells on the upper side of the bundle, and a large patch below, extending to the epidermis.

Xylem vessels small, in groups of two to five.

Erica ciliaris.

Leaf Characters.—Leaves petiolate $\frac{1}{2}$ mm., ovate $3\frac{1}{2}$ mm. $\times$ 2 mm., margins revolute, exposing seven-eighths of the under surface.

Lamina and petiole pubescent, leaf margins bearing many glandular hairs in two to three rows.



A. T.S. Leaf of *Erica Tetralix* ($\times 105$).
B. T.S. Leaf of *Erica Mackayi* ($\times 105$).
C. T.S. Leaf of *Erica Crawfordii* ($\times 105$).

Anatomy.—Upper epidermal cells relatively large, tangentially elongated 32·5 $\mu \times$ 21·5 μ, cuticularised 3·5 μ in thickness.

Short unicellular hairs may occur on the upper surface. Numerous long, rigid, glandular hairs on leaf margins.

Lower epidermal cells very small, irregular in shape, cuticularised.

Stomata small, guard cells projecting slightly above the level of the epidermis.

Simple, short, curved, papillate hairs very numerous, four to six arching over the stoma. Simple, long, straight, papillate hairs on the mid-rib.

The bundle is small, circular, almost completely surrounded by a stereome, which is more developed on the upper and under sides of the bundle. Two to three rows of parenchyma intervene between the stereome and the lower epidermis.

Xylem vessel very small, in groups of two to five.

An analysis of *E. vaganis* was made but need not be quoted, since it does not add anything to the argument.

Erica Praegeri (*E. Tetralix* × *E. Mackayi*).

Leaf Characters.—Leaves petiolate $\frac{2}{3}$ mm., linear-oblong (*i.e.* intermediate between *E. Tetratix* and *E. Mackayi*) $4\frac{1}{3}$ mm. $\times 1\frac{2}{3}$ mm., margins revolute, exposing four-fifths of the under surface.

Glandular hairs occur on leaf margins in one to two rows; simple hairs few, scattered.

Anatomy.—Upper epidermal cells large, irregular, varying from 27 $\mu \times$ 30·5 μ to 21·5 $\mu \times$ 21·5 μ, cuticularised 7 μ in thickness. Approximately 50 per cent. of the upper epidermal cells show a transverse septum dividing the cell into two more or less equal parts (cf. *E. Mackayi*).

Lower epidermal cells small, oblong, cuticularised. Guard cells of stomata project above the level of the epidermis.

Simple, short, curved, papillate hairs occur on the under surface, two to four arching over the stoma (cf. *E. Mackayi*). No hairs on the mid-rib (cf. *E. Mackayi*).

The bundle is ovoid in outline (*i.e.* intermediate between *E. Tetralix* and *E. Mackayi*). The stereome consists of a small patch of cells on the upper side of the bundle and a larger

patch below (cf. *E. Mackayi*). One to two rows of parenchyma intervene between the stereome and the lower epidermis (cf. *E. Tetralix*).

Xylem vessels small, in groups of two to five (cf. *E. Mackayi*).

Erica Stuartii (*E. Mackayi* × *E. mediterranea*).

Leaf Characters.—Leaves petiolate 1 mm., linear-oblong $3\frac{1}{3}$ mm. × $1\frac{1}{4}$ mm., margins revolute, exposing two-thirds of the under surface.

No glandular hairs, few simple hairs, more numerous on the petiole.

Anatomy.—Upper epidermal cells small, irregular, varying from 30·5 μ × 30·5 μ to 21·5 μ × 18 μ, strongly cuticularised 7 μ in thickness.

Approximately 50 per cent. of the upper epidermal cells show a transverse septum dividing the cell into two more or less equal parts (cf. *E. Mackayi*).

Lower epidermal cells small, oblong, and less strongly cuticularised.

Stomata large, guard cells projecting above the level of the epidermis (cf. *E. Mackayi*).

Simple, short, curved, papillate hairs occur on under surface, two to four arching over the stoma (cf. *E. Mackayi*). Long, straight, simple hairs on the mid-rib.

Bundle is small and triangular in outline, the base being parallel to the lower epidermis. The stereome consists of a small patch of cells on the upper side of the bundle and a large patch below. A layer of parenchyma intervenes between the stereome and the lower epidermis.

Xylem vessels very small, in groups.

Erica Crawfordii.

Leaf Characters.—Leaves petiolate $\frac{2}{3}$ mm. oblong, 3 mm. × $1\frac{1}{3}$ mm., margins revolute, exposing about four-fifths of the under surface (cf. *E. Mackayi*).

Lamina and petiole glabrous, except the leaf margins which bear one row of large glandular hairs (cf. *E. Mackayi*).

Anatomy.—Upper epidermal cells large, radially elongated 32·5 μ × 36 μ, cuticularised 8 μ in thickness. All the epidermal

cells with few exceptions show a transverse septum, dividing the cell into two approximately equal parts (cf. *E. Mackayi*).

Lower epidermal cells small, oblong, and cuticularised. Guard cells of stomata project above the level of the epidermis.

Simple, short, curved, papillate hairs occur on the under surface, two to four arching over the stoma (cf. *E. Mackayi*). No hairs on the mid-rib (cf. *E. Mackayi*).

The bundle is smaller than that of *E. Mackayi*, triangular in outline, the base being parallel to lower epidermis (cf. *E. Mackayi*). The stereome consists of a very small patch of cells on the upper side of the bundle, and a large patch below, extending to the epidermis (cf. *E. Mackayi*).

Xylem vessels small, in groups of two to five (cf. *E. Mackayi*).

Discussion.

A distinctive feature which has emerged is the peculiar epidermis in *E. Mackayi*. This character appears in no other species but it is seen in the hybrids *E. Praegeri* and *Stuartii*, both of which have *Mackayi* as one of their parents. It also occurs in *E. Crawfordii*.

If *E. Mackayi* were a sub-species or variety of *E. Tetralix* it is strange—

1. That it is glabrous save for glandular hairs of the ordinary type.
2. That there should be no knuckle-bone-shaped glands.
3. That the epidermal cells should be different in size and shape, and that they should show this clear transverse wall.
4. That the bundle and stereome should differ so markedly.

If *E. Mackayi* were a hybrid between *E. Tetralix* and *E. ciliaris*, then it should be intermediate between its parents, which it is not, neither in leaf-shape, character of the epidermal cells, nor bundle and stereome characters.

E. Watsonii is a natural hybrid between *E. Tetralix* and *E. ciliaris*, resembling one of its parents strongly in some features while in others being completely intermediate.

It seems therefore that *E. Mackayi* is certainly specifically distinct from *E. Tetralix* and is not a hybrid.

Erica Crawfordii can be seen to resemble *E. Mackayi* very strongly, and is probably a form *flore pleno* of it.

E. Praegeri is intermediate between its parents *E. Tetralix* and *E. Mackayi* in

(1) Amount of curvature of leaf.
(2) Leaf-shape and hairs.
(3) Character of upper epidermal cells.
(4) Bundle characters.

Summary.

The following important conclusions from the anatomy of the leaves seem to be justified :—

1. That *Erica Mackayi* is even more distinct from *Erica Tetralix* than has been thought.

2. That *Erica Crawfordii* is unmistakably more closely connected with *Erica Mackayi* than with any other species, and is almost certainly a double-flowered form of it.

3. That the Irish hybrid heath known as *Erica Praegeri*, which was described by Dr. Ostenfeld and presumed to be of hybrid origin, is in all probability correctly so regarded. At any rate, the *Mackayi* influence is unmistakable, while the *Tetralix* influence may be reasonably inferred.

The Recognition of some Agricultural Grasses by their Vegetative Characters. By J. H. Whyte, B.Sc.

(Read 23rd January 1930.)

The following key is an attempt to give the main vegetative characters of the most common of the agricultural grasses of Britain, and to act as an introduction to the grasses when they are not in flower.

I. Leaf Blade Expanded.

A. SHEATH COLOURED.

(*a*) Hairless.

1. Sheath round.

i. Red colour.

(*x*) Basal margin of leaf smooth; ligule large. Veins of leaf indistinct when held up to the light. T.S. of leaf shows no girders *Lolium italicum*

(*y*) Basal margin of leaf rough; ligule small. Veins distinct when held up to the light. T.S. of leaf shows girders . . *Festuca pratensis*

ii. Dark brown or with a tinge of violet *Alopecurus pratensis*

2. Sheath flat.

i. Red colour . . . *Lolium perenn*

ii. Yellow . . *Cynosurus cristatus*

(*b*) Hairy.

Sheath round.

White with red veins. Tufted habit of growth . . . *Holcus lanatus*

B. SHEATH COLOURLESS.

(*a*) Hairless.

1. Sheath round.

i. Ribs very low and flat; basal margin of leaf upwards rough; ligule longer than broad, thin and toothed *Phleum pratensis*

ii. Ribs prominent; blade rough on both sides; ligule long, hairy on the back *Agrostis alba*

iii. Two tufts of hair at the junction of the leaf, blade, and sheath *Anthoxanthum odoratum*

2. Sheath flat, with rounded edges.
Ribless grasses with median lines.
i. Blade relatively thick and hard or fleshy, dark coloured when held up to the light; ligule short. Rounded apex, edges of leaf parallel. Note conspicuous motor cells in T.S. . . . *Poa pratensis*
ii. Blade soft and thin, light coloured when held up to the light. Leaf apex rounded, edges of leaf not parallel; ligule prominent; lower surface of leaf dull or slightly shining . . . *Poa annua*

3. Sheath flat, edges acute.
i. Ribless grasses with median lines.
Acute apex, blade tapering from base; ligule acute; lower surface of leaf shining . . . *Poa trivialis*
ii. No median lines.
Large ribless blades, tapering from about the middle to an acute apex; under surface of leaf dull . *Dactylis glomerata*

(*b*) Hairy.
i. Soft and downy.
(*x*) Sheath white with red veins *Holcus lanatus*
(*y*) Sheath not characteristically coloured . . . *Bromus mollis*
ii. Not soft and downy.
(*w*) Blade low, acute ribs; single row of hairs along each rib; sheath not keeled, very little on blade *Avena flavescens*
(*x*) Blade with low, flat ribs, hairs sparse, sheath keeled . *Avena elatior*
(*y*) Small round ears at base of blade, also beard of hair *Anthoxanthum odoratum*
(*z*) Base of leaf with pointed ears; ligule reduced to a mere margin; fringed with teeth like hairs *Triticum repens*

II. Bristle Bladed Grasses.
i. Ligule conspicuous—thick and obtuse. T.S. of leaf shows girders to some or all of the vascular bundles *Nardus stricta*
ii. Ligule inconspicuous—ear-like ligule at base of culm leaf. T.S. No girders *Festuca ovina*

When using the key the following hints should be kept in mind. The easiest method to test for the roughness of the leaf margin is to draw it backwards and forwards along the

tip of the tongue. The type of rib is best detected by bending the blade round the finger and examining the upper surface. Hairiness is best seen by looking along the surface of a grass and not at it. The median lines, which are best seen when the leaf of any of the *Poas* is held up to the light, are two parallel lines of lighter tissue ; these lines run along the centre of the grass blade and are separated by a dark band of tissue. The term " girders " is used to indicate the bands of strengthening tissue which are sometimes found stretching from the vascular bundles to the epidermis.

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The Spread of Bracken by Spores.

By J. H. Whyte, B.Sc.

(Read 24th April 1930.)

Bracken is generally believed to spread mainly by vegetative means, and that the increase due to the germination and development of spores is very rare. The following notes are intended to show that the spread of bracken by spores is neither impossible nor rare.

An interesting case where bracken may have increased by means of spores can be seen from the Corrie slopes of Ben Lui. On the hills opposite there are hundreds of small bracken patches above the tree-line, which appear to be most frequent in the smaller valleys and near water. Professor Braid of the West of Scotland College of Agriculture is of the opinion that they must be due either to fresh infections or to the breaking up of the old continuous areas. Considering the position of these patches, mainly near moisture, one of the chief factors in the development of fern prothalli, and away from trees which alone could suppress bracken in such a site, one is inclined to believe that these are fresh infections due to spore dissemination.

In the field when examining plants thought to be sporelings great care must be taken, as is shown in a case quoted by Professor Braid. He found tiny plants on very wet ground which appeared to be sporelings, but after being removed from the soil were found to be attached to the remains of a large rhizome, and were the last stages of a bracken area which had been drowned out. Farrow (1) has found sporelings in the mouth of a rabbit burrow which was far removed from a bracken area. Such a case is open to doubt, as there is no reference as to whether or not a plant was dug up in order to ascertain if there was any suggestion of old rhizome present, since there is the chance of a piece getting there by mechanical agencies.

Margaret Benson and Elizabeth Blackwell (2) mention definitely the establishment of bracken by spores. Cases equally well authenticated, though not published, have

occurred in Scotland. Professor Lang of Manchester University found prothalli and sporelings in all stages of growth on Flanders moss on the site of a fire; also Professor Bower mentions a profuse growth of prothalli which was found on peat sent into Glasgow Botanic Gardens.

W. J. Lucas (3) states: "Should anyone wish to ornament a corner of a garden by means of a clump of bracken, a piece of rhizome must be procured; or, better still, tiny plants that have developed from spores on a patch of charcoal and earth, or where fir branches have been burnt in Ester Woods. I can say from experience how a fine bed of bracken some 3 feet to 4 feet high may be obtained in three to four years from tiny plants only an inch or two in stature."

In the paper by M. J. Laurent (4) there are references to the establishment of bracken after the prevailing vegetative community has been upset. "Burnt soil rich in phosphate of potash contains also particles of charcoal which hinder growth of fungi. This gives a proper medium for the germination of spores and the growth of the prothallus."

Thus we see that a favourite place for the establishment of bracken from spores is on the site of a fire. M. J. Laurent (4) is of the opinion that this is due to the presence of the charcoal, but a more likely explanation is that the fire has sterilised the surrounding soil, and that it is due to the fire, and not to the presence of the charcoal, that fungal growth is prevented and germination of bracken spores takes place.

In a bracken community the struggle for existence is intense, and the community is spoken of as a closed phase. But if such a community is partially opened there is a chance of the bracken sporelings growing. The presence of moisture is also essential for the development of the bracken plant from the prothallus. Thus we see that in certain seasons and under certain conditions we do get the establishment of bracken by means of the spreading of spores.

In conclusion I should like to express my indebtedness to Professor Braid of Glasgow, who gave me many helpful suggestions, and to Professor Bower and Professor Lang for permission to publish some data supplied by them.

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Experiments with Vita Glass. By R. J. D. Graham and L. B. Stewart.

(Read 24th April 1930.)

Reports on the value to horticulture of glass which permits the passage of ultra-violet rays are contradictory as regards the effect on growing plants (Jour. Roy. Hort. Soc., lv, 1930, 79). Commercially the results are uniformly adverse, as neither the increased crop, earliness, nor the saving in time compensates for the increased capital outlay incurred by the installation of special glass.

Experiments were carried through at the Royal Botanic Garden, Edinburgh, between May and September 1929. Small frames, outside measurements 21 inches by 23 inches by 28 inches, were glazed on all sides and tops with Vita Glass. Controls were glazed with glass of the same thickness as Vita. The top of each frame could be elevated for ventilation. In all twelve frames, six Vita and six Ordinary Glass, were employed. The series of twelve frames was arranged in two sets permitting the height of the top to be either 28 inches or 21 inches from the ground.

The frames were placed on beds consisting of light loam previously cultivated, without the application of manure. Seeds were drilled uniformly in the frames, and after germination the seedlings were thinned to give an equally spaced stand of plants. All cultural operations, including watering and ventilation, were carried out similarly for each set of frames.

Throughout the course of the experiment the amount of ultra-violet light reaching the plants was measured by an acetone methylene blue gauge.

The monthly records in gauge units are :

	Vita.	Ordinary.
May . .	55	44
June . .	78	50
July . .	50	39
August .	35	27
September .	31	24

The crop was weighed immediately after removal from the soil. In addition, where crops are cultivated for special parts, these were separately weighed.

Experiments: (1) Turnips.

Golden Ball and Milan Purple Top were sown on 30th April, and harvested on 12th and 20th June respectively. A second sowing of Milan Purple Top was made on 29th May and harvested on 7th July.

		Weight of Whole Plant in Ounces.	Weight of Roots.	Methylene Blue Units.
Golden Ball	Vita	186	35	76
	Ordinary	168	37	62
Milan Purple Top, First Crop	Vita	81	40	106
	Ordinary	98	43	78
,, Second Crop	Vita	74	41	103
	Ordinary	75	38	67

Analysis revealed no difference in composition in Milan Purple Top grown under Vita Glass and Ordinary. In both the moisture was 91·7 per cent.

(2) Radish.

A sowing of White Turnip Radish was made on 12th June, and harvested on 15th July. A second sowing was made on 28th June along with a sowing of Scarlet Globe Radish, both being harvested on 4th August.

		Weight of Whole Plant in Ounces.	Weight of Roots.	Methylene Blue Units.
Turnip White, First Crop	Vita	32	18	74
	Ordinary	38	30	45
,, Second Crop	Vita	55	13	57
	Ordinary	33	10	43
Scarlet Globe	Vita	45	26	57
	Ordinary	31	18	43

(3) Beetroot.

Bell's Deep Blood Red and Half-long were sown on 8th July and harvested on 27th September.

		Weight of Whole Plant in Ounces.	Weight of Roots.	Methylene Blue Units.
Bell's Deep Blood Red	Vita	156	48	100
	Ordinary	133	37	80
Half-long	Vita	118	47	100
	Ordinary	131	57	80

(4) Various.

Dwarf Green curled Savoys were planted on 30th April and removed on 22nd July. Buckwheat was sown on 1st May and harvested on 27th June. Maize was sown on 2nd May and harvested on 30th June. Carrot, St. Valery, was sown on 13th July and pulled on 27th September.

		Weight of Whole Plant in Ounces.	Weight of Roots.	Methylene Blue Units.
Savoy	Vita	184	..	169
	Ordinary	147	..	121
Buckwheat	Vita	79	..	126
	Ordinary	66	..	90
Maize	Vita	55	..	133
	Ordinary	67	..	94
Carrot	Vita	51	20	93
	Ordinary	59	24	86

Summary.

1. Results favourable to Vita Glass were obtained with Savoys, Bell's Deep Red Beet, and White Turnip Radish in the second crop.

2. Significant results unfavourable to Vita Glass were obtained in Maize, Half-long Beetroot, and in the roots of White Turnip Radish in the first crop.

3. The average ratio of transmission of ultra-violet rays during the experimental period by Vita and Ordinary Glass was 5·4, the maximum being in June, when 8·5 was obtained.

Our thanks are due to Professor F. G. Baily for many suggestions in connection with the measurement of light, to Professor P. S. Lelean for assistance in obtaining the methylene blue gauge, and to Mr. J. J. Blackie for analysis of the Turnip crop.

Vegetative Propagation of Broccoli from Heads. By R. J. D. Graham and L. B. Stewart. (With Pl. XV.)

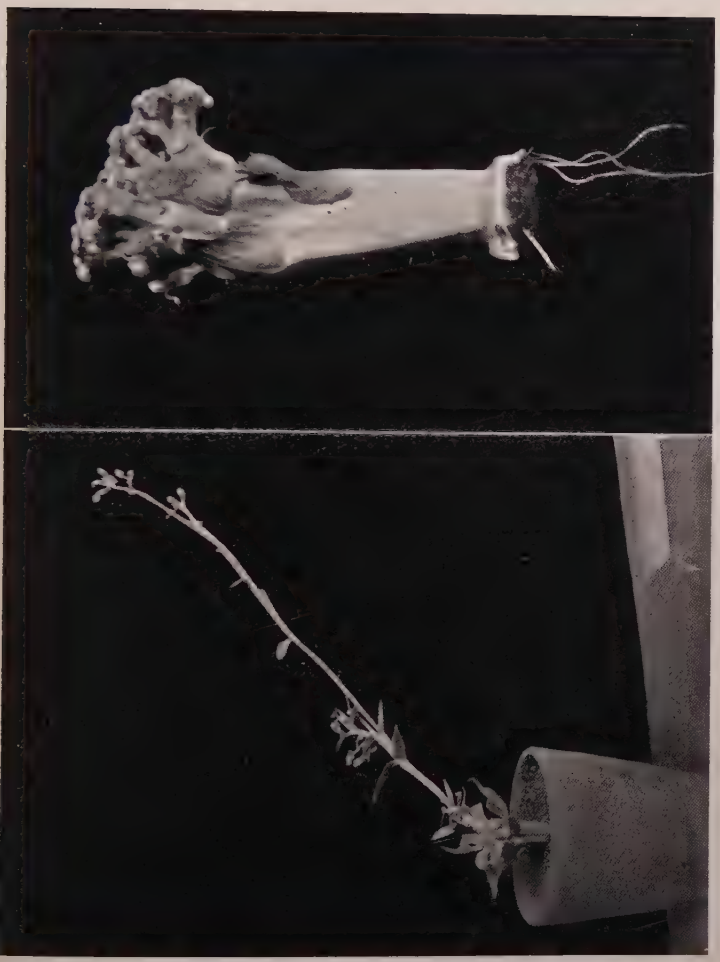
(Read 15th May 1930.)

The propagation of young flowering shoots of plants for ornamental purposes is well known in horticulture, but so far as the authors are aware the propagation of broccoli from the sterile inflorescence is recorded now for the first time. Almost a century ago, however, a method of propagating cabbage was described ("Gardeners' Magazine," ix (1833), 226). The experiments were undertaken in response to an appeal for assistance from the School of Agriculture, Cambridge.

The material received in a crate consisted of twenty-four heads. These were exploited in various ways, the most satisfactory material proving to be pieces of curd consisting of a portion of the sterilised inflorescence with the attached scale leaves. The most satisfactory environment was one with low humidity, good ventilation, and a night temperature of 55° F. Thus treated, roots developed in twenty days (fig. A), and after a further period of twenty days elongation in the flower axis had taken place with accompanying enlargement and development of chlorophyll in the scale leaves. So successful was the subsequent development that in the first week of June—the experiments having commenced at the end of February—normal flowers opened (fig. B).

Detached green leaves with a shield-like portion of stem attached also rooted freely, and though giving promise of better plants, have been markedly slower in development. Portions of curd with green leaves attached were also rooted, but at a later stage the curd decayed, causing the death of the cutting.

This method of propagating broccoli opens the possibility of securing seed when, for special reasons, seed cannot be otherwise obtained. Owing to self-sterility in certain members of the genus *Brassica*, and particularly in broccoli, it is advisable to propagate from several heads in order to overcome this difficulty.



A.

B. Rooted Broccoli inflorescences.

Summary.

1. Propagation of broccoli from the sterile inflorescence is described.

2. To obtain seed, the propagation of portions from more than one plant is recommended.

Development and Anatomy of Monocotylous Seedlings. 1. Paris polyphylla. 2. Costus speciosus.

By Lucy Boyd, B.Sc.

(Read 15th May 1930.)

1. Paris polyphylla.

Although a copious literature dealing with Liliaceous seedlings exists, very little refers to the tribe Medeolae and no account was found of the germination of the British *Paris quadrifolia* or of the Himalayan species, *P. polyphylla*. The present investigation consisted of an examination of fourteen seedlings of the latter at various stages of development.

The embryo is a small, undifferentiated body (2) lying in very hard endosperm, the seed being enclosed in a berry. The seeds germinate after seven months. The primary root emerges, followed by the base of the cotyledon which ensheathes the plumule and carries it deeper into the soil. The cotyledon is differentiated later into :

(i) A sheathing base, the limits of which cannot be determined from the external morphology : it functions as a food-storing as well as a protective organ.

(ii) A cylindrical stalk, curved in the young seedling (fig. 1, I*a*), later erect : its length is 6 mm. and it is grooved on the adaxial side in a six-months-old seedling.

(iii) A broad distal portion with inrolled margins and tip imbedded in the seed. In a few months it erects itself and expands to a green lamina, which continues to increase in width and length. In shape it is cordate : ocelli on the margin give it a finely serrated appearance. Its strong midrib is reinforced by a reticulum formed of 3–4 pairs of laterals. The two lower pairs of laterals tend to converge with the midrib at the base. This is repeated in the first foliage leaf, which is similar in shape (fig. 1, III*a*). Finally, in the leaf from a whorl on the floral axis, three pairs of laterals diverge from the base.

Development of the plumule is slow. After four or five months a short outgrowth emerges laterally, below soil level, from the swollen base of the cotyledon (fig. 1, I*a*). Its course

is slightly oblique and it pushes out the epidermal layers of the sheath. The primary root is a powerful organ, stout and

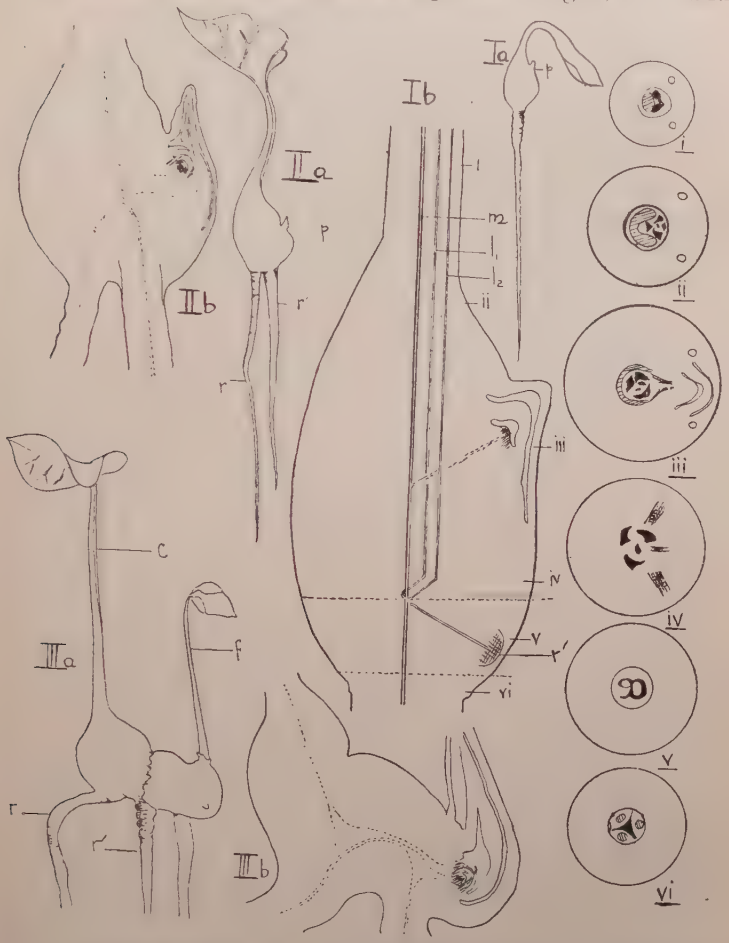


FIG. 1.—*Paris polyphylla*. 1*a*. Four-months-old seedling. *b*. Longitudinal section of *a* showing levels corresponding to transverse sections i–vi, horizontal dotted lines indicate the limits of the hypocotyl; development of the rhizome is seen in a six-months old (II*a*, *b*) and a year-old (III*a*, *b*) plant, dotted lines showing course of vascular strands.

c=cotyledon; f=first foliage leaf; m=main strand of cot; p=plumular bud; l_1, l_2=two lateral strands of cot; r=primary root; r′=cauline root.

tough, its length always greater than that of the aerial part of the plant. It early assumes a contractile function due to the collapse, in bands, of cortical cells. Its work is unshared

by cauline roots for six months, although meristem for such is laid down almost from the beginning of germination.

Anatomy of Four-months-old Seedling.—The lamina of the cotyledon has an upper epidermis of large thin-walled cells, a layer of small palisade cells, well-ventilated mesophyll, and a lower epidermal layer consisting of small regular cells. Phloem and xylem are equally developed. In the stalk portion (fig. 1, i) one central strand, a double bundle, runs through a ground mass of parenchyma, accompanied by two smaller lateral strands, each enclosed in a sheath. The stalk gradually merges into the sheathing base, with its widening storage region. At the level where the plumular bud arises (fig. 1, ii and iii) the central strand becomes less compact and a crescent of phloem disposed opposite to the plumular faces three xylem groups. The vascular tissue supplying the plumule makes little change in this arrangement. Below this level a central protoxylem and four metaxylem groups are scattered in a ground-mass of phloem and parenchyma. The lateral strands of the cotyledon fuse with the central strand, 0·5 mm. lower, a region which may be taken as the upper limit of the hypocotyl (fig. 1, iv, and I*b*).

In the hypocotyl there is an increase in girth of cortical storage cells packed with starch grains, and isolated raphides occur. The stele is ensheathed by an endodermis. The transition is slow, the hypocotyl being 0·5 mm. long. The xylem, seen in transverse section at this stage, is disposed in closed or open rings, which are buttressed outside and inside by phloem. These rings disintegrate, the protoxylem is orientated outwards and the phloem rearranges itself, giving finally a typical triarch root stele, marking the lower limit of the hypocotyl. Externally, however, there is perfect continuity of epidermis and swollen cortex; the diameter is 1·5 mm., which does not differ perceptibly from the maximum. There is a sudden diminution in the width of the cortex at a stage 0·2 mm. lower, and the root assumes its usual appearance. Near its tip, the root has a diarch, then a monarch stele.

Development of the Rhizome.—The lateral position of the plumule and the oblique direction of its strands are obvious in the youngest seedlings (fig. 1, I*b*). In a six-months-old seedling the strands from the first foliage leaves and plumular meristem follow an almost parallel course, horizontally (fig. 1,

II*a*, *b*), converging in the centre of the swollen mass to meet the cotyledonary tract which has been diverted from the vertical. A strong, efficient cauline root is produced, immediately below the plumular bud, in order to meet its requirements, in its somewhat isolated position, thus giving a more balanced arrangement but throwing the primary root into an apparently lateral position.

The horizontal traces in a year-old seedling (fig. 1, III*a*, *b*) function as the vascular system of a rhizome with the plumule at the end of the first node, protected by young leaves. The base of the cotyledon and hypocotyl still persist at the other end covered by the original epidermis, which has been ruptured by the growth of the rhizome. The cotyledonary strand maintains connection with the plumule by a necessarily indirect course and also with the primary root. A single foliage leaf appears above the soil in the first season. After a further year's growth the rhizome is deeper in the soil and about 7 mm. in length (3 mm. of this being the original hypocotyl). A thin membrane covers the rhizome and overlaps the sheaths at the point of the rhizome, which is monopodial. In this second year the first axis bearing a whorl of leaves appears—the whorl consisting of three, four, or five leaves.

The seedling is noteworthy for its simplicity of structure and slow development of the plumule, which results in the relegation to the cotyledon of photosynthesis and food storage for the first year. The similarity between the cotyledon and first foliage leaf is interesting, as is the early indication of a horizontal monopodial rhizome. It was hoped that the slow ontogenetic development might reveal points of phylogenetic value, and the fairly lengthy transition in a hypocotyl of measurable dimensions gives sections with steles reminiscent of the dictyostele and solenstele of Ferns. It is difficult to say, however, how far these are the result of the tuberous nature of the hypocotyl. Such steles were not found in the hypocotyl of *Trillium oratum*, a closely allied and very similar plant, nor in seedlings of the Araceae, which in their habit bear a resemblance to *Paris*.

2. Costus speciosus.

In addition to its own peculiar features, the seedling of this plant affords an interesting comparison with that of *Paris*.

Costus is the sole genus in the sub-family Costoideae which, with another, Zingiberoideae, composes the Zingiberaceae.

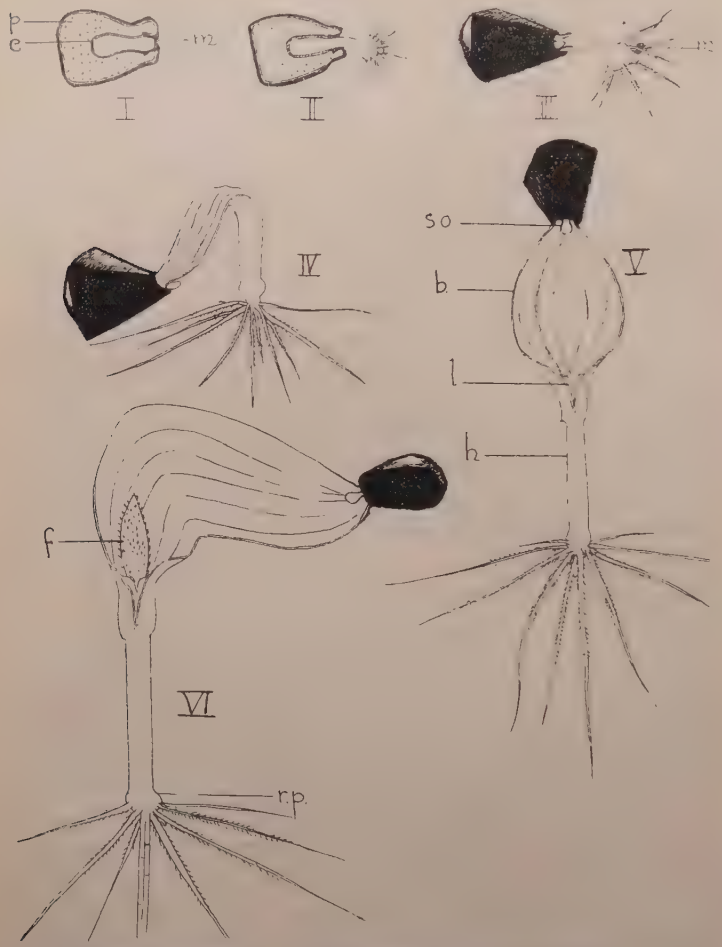


FIG. 2.—*Costus speciosus*. I. Ripe embryo. II–IV. Seedlings one, two, and three days old. V. Six-weeks-old seedling. VI. Twelve-weeks-old seedling.

b=blade of cotyledon ; f=first foliage leaf ; e=endosperm ; p=perisperm ; h=hypocotyl ; s.o.=spherical outgrowth ; m=germinal lid ; r.p.=root plate ; l=ligule.

The phyllotaxy, which is an important diagnostic feature in the division into sub-families, is abnormal in *Costus*, as Lindman (5) has pointed out. Further, the study of the

seedling was recommended in 1896 by Humphrey (4) who made a thorough investigation of the seed before germination. He describes a highly differentiated embryo (fig. 2, I), cylindrical and straight with two or more rudimentary leaves and four accessory roots, lying in a copious endosperm of aleurone, surrounded by a starchy perisperm. A lid closes the testa at the mouth of the micropylar collar, with which, however, it is not in organic continuity. On germination the lid is pushed out. A definite precise mechanism for the emergence of the radicle therefore exists. The type of germination is similar to that of *Paris*. The seeds germinated in three weeks, and seven were examined.

One-day-old Seedling.—Marked elongation of that part of the embryo behind the radicle results in the emergence of the latter, covered with a mass of root hairs (fig. 2, II). *Twenty-four hours later* (fig. 2, III) eight strong rootlets of cauline origin (four of them doubtless Humphrey's accessory rootlets) arise, arranged in a ring on the wide basal region above the pointed apex, which represents the primary root. The cylindrical region, embodying hypocotyl and base of cotyledon, is unchanged, but there is now visible a short flattened portion of the cotyledon with incurved margins. A small green spherical outgrowth, $\frac{1}{2}$ mm. or less in diameter, blocks the circular micropylar opening.

Three-days-old Seedling (fig. 2, IV).—The flattened part is the blade of the cotyledon, ribbon-like, photosynthetic, fleshy and with parallel venation, terminated at one end by the green outgrowth, at the other by its fusion to the axial portion of the seedling. The blade is bent, for the suctorial tip is in the seed which is at the level of the soil. It becomes erect and carries the seed at its tip after seven days.

Six-weeks-old Seedling (fig. 2, V).—The cotyledon blade has lengthened to 12 mm., widened to 9 mm., and increased in thickness. The first leaf is to be seen, its adaxial side closely adpressed to the blade of the cotyledon. Its base is well protected by a small, green, ligular collar of fleshy tissue (fig. 2, V, *l*), to which it is almost fused. This sheath is more conspicuous in the oldest seedling examined (fig. 2, VI), which shows increased growth of the lamina of the cotyledon and the system of cauline roots. The shortness of the latter, which grow from a stout root plate at the base of the lengthy

hypocotyl, is compensated for by their number and arrangement, which give good anchorage to the plant.

Anatomy of three-days-old Seedling (fig. 3).—Six vascular strands traversing the cotyledonary tip are reduced to five at the micropyle, after which the cotyledon assumes an elliptical,

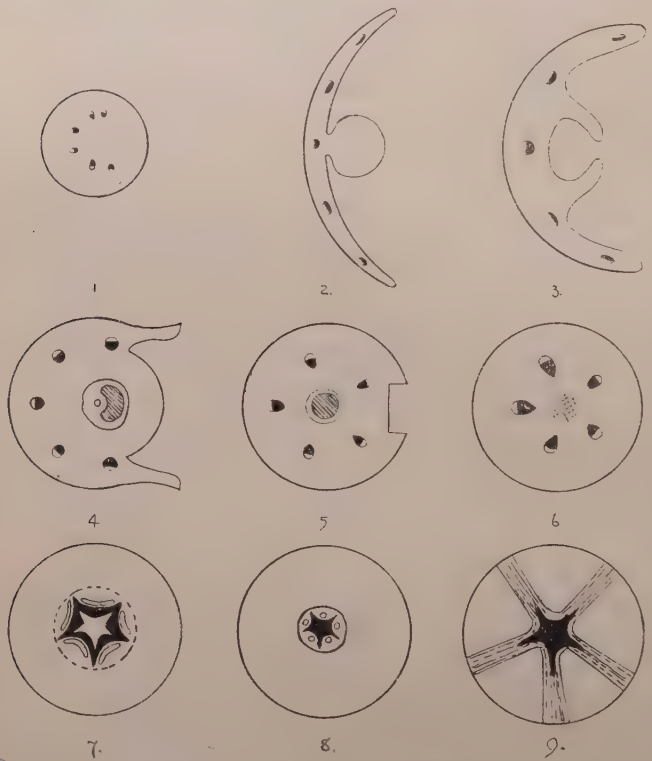


FIG. 3.—*Costus speciosus*. Sections of seedling V in fig. 2 taken from tip of cotyledon downwards to the root plate (diagrammatic).

then a more flattened cross-section. At this juncture the green spherical outgrowth appears on the upper side of the cotyledon, opposite the midrib. The vascular strands are unaffected by its presence. It is non-vascular (fig. 4), with a thinly cutinised epidermis, provided with numerous stomata.

The internal tissues of the blade of the cotyledon are well differentiated. Lower and upper epidermis are identical, stomata occurring in both. The sub-epidermal layer on each

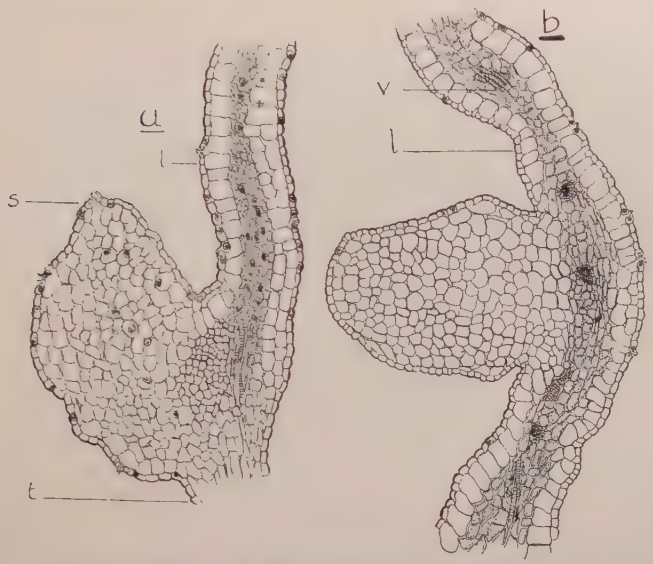


FIG. 4.—*Costus speciosus*. *a*. Median longitudinal section through lamina of cotyledon where outgrowth occurs. *b*. transverse section of *a* (Camera lucida drawing).

s=stoma ; l=lamina of cotyledon ; v=vascular strand of cotyledon ; t=suctorial tip of cotyledon.

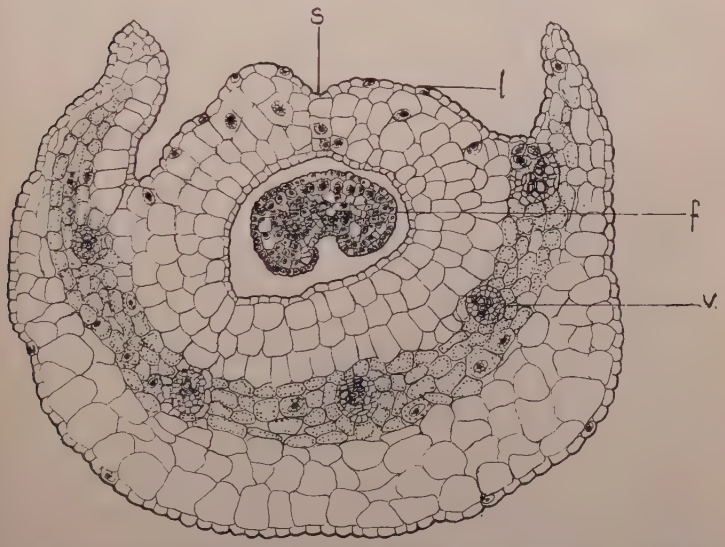


FIG. 5.—*Costus speciosus*. Transverse section through the basal end of the blade of the cotyledon showing the origin of the ligule (Camera lucida).

l=ligule ; v=vascular strand of cotyledon ; f=first leaf of plumule ; s=region of weakness where slit will occur.

side functions as a water-storage region. The photosynthetic tissue consists of mesophyll. At the base of the lamina the margins curve inwards (fig. 3, 3rd section). The layer of sub-epidermal cells on the upper surface is replaced by four layers of parenchyma which arch outwards and bridge the gap between the two margins (fig. 5). This arch indicates the beginning of the sheath protecting the plumule and is non-vascular. The necessity for it is apparent, for the margins of the blade make no attempt at overlapping or fusing with each other.

Externally only a slight decrease in diameter marks the upper limit of the hypocotyl. A central cylinder of compact tissue, consisting chiefly of five plumular traces, is surrounded by a ring of five massive cotyledonary traces disposed at equal intervals on the inner periphery of a broad cortical zone (fig. 3, 6). The cotyledon strands pass to the centre at a level 150 μ lower. The stele has a ring of xylem with ten protoxylem rays, between which lie small patches of phloem. It quickly changes to a medullated pentarch form, which is constant throughout the length of the hypocotyl: at the base, the xylem becomes consolidated to a plate from which cauline roots arise (fig. 3, 9).

The above arrangement is typical, but in older seedlings the greater number of plumular strands fusing with the cotyledonary traces complicate the hypocotylar structure; in the oldest seedling, for example, two very weak traces descend through the wide pith of the stele in the hypocotyl.

No adequate explanation can be put forward to account for the outgrowth at the distal end of the cotyledon. It may act as a stopper, closing the circular aperture of the testa, yet none exists in seedlings with a like germination mechanism, e.g. *Commelina*, *Hemerocallis*. The absence of vascular tissue disposes of the suggestions that it is a hydathodal structure on a large transpiring surface, or a result of the buckling up of vascular traces in their passage from a wide lamina to a microscopic cylindrical tip. That it is a vestigial structure, remaining from a period when the cotyledon was not differentiated into lamina and tip but was cylindrical and partly solid, is problematical. The difficulty in deciding its nature is comparable to that raised by the epiblast of the seedlings of some Gramineae (3). This is also a small non-vascular structure, the cotyledonary origin of which is less

clear owing to the more complicated form of the grass embryo with plumular axis and cotyledon fused. Further speculation in this connection is raised by considering the resemblances existing between the grasses and Zingiberaceae. The German systematists consider the Scitamineae a series co-ordinate with the Glumiflorae, and Sargant and Arber (7), in their study of the comparative morphology of the grass embryo, draw much of their evidence from the anatomy of seedlings of Zingiberaceae.

The biological necessity for the ligular sheath at the base of the cotyledon lamina is apparent, for the cotyledon as a sheathing organ is useless. Its interest lies in that it is not that prolongation of the sheathing base into a hood, seen so commonly in the monocotyledonous seedling and designated "ligule," but a true ligule such as develops on the leaf of the adult *Costus* and is typical for the leaf of Zingiberaceae. A seedling such as *Gloriosa* (Liliaceae), or *Tigridia* (Iridaceae), figured by Arber (1), requires no marked photosynthetic activity on the part of the cotyledon, the chief work of which is protection, achieved by the adoption of the hooded "ligular" form. The plumule of *Paris* is adequately protected by the sheathing base, so the dominant part of the cotyledon is green lamina, with no ligule. *Costus* compromises between the two types. The continued growth of the hypocotyl, giving strength and mechanical efficiency, with its hollow, cylindrical stele, are a response to the increasing demands of the cotyledon for better support and light.

Seedlings of the Zingiberoideae resemble *Costus* in the type of embryo, endosperm, and seed, in their almost entirely adventitious root system and in the insignificant, if not actually absent, basal sheath of the cotyledon. On the other hand, they lack the lengthy hypocotyl and green cotyledonary blade of *Costus*, and even a stalk homologous to the blade is absent. They have no open ligular sheath, but a cotyledon consisting chiefly of hooded "ligule" (7, text-figs. 31, 34). The first leaf of *Costus* is a true foliage leaf, not an attempt at one; in the majority of Zingiberoideae the true adult form of leaf is not produced until one or more simple scale leaves have preceded it. All the Zingiberoideae examined have in the cotyledon two strands equivalent to Sargant's "double bundle" (6). *Costus*, however, has a large number of strands

(five and upwards) and, as frequently happens in such cases, not a constant number.

Their geographical distribution points to the Zingiberaceae being an ancient group, and the sub-family Zingiberoideae show in their seedlings primitive features. The requirements of the adult form, and consequent physiological demands, upon the young plant have been such that the seedling could afford to be conservative. In its endeavour to obtain maximum light, *Costus* broke away from its relations in adopting a new phyllotaxy. The above observations seem to indicate that, having lost in the ontogeny all stages that mark a simple structure, it has likewise evolved for itself a precocious type of seedling, which shows, from the beginning, not only advanced differentiation and remarkable efficiency in structure, but also several features belonging to the adult plant.

Thanks are due to Professor Wright Smith for providing facilities for this study, to Professor J. R. Matthews and Dr. R. J. D. Graham for their interest and encouragement, and to Mr. L. B. Stewart, through whose agency the seedlings were obtained.

Summary.

1. The seedling of *Paris* develops slowly. During the first year the cotyledon is the sole food-manufacturing and chief storage organ. The hypocotyl also is swollen with starch.

2. The anatomy is simple. The lateral strands of the cotyledon pursue a very long course before joining with the main strand at the upper limit of the hypocotyl, which is lengthy. The transition to root structure takes place gradually.

3. The initiation and development of a monopodial rhizome are described. The cotyledon resembles the first leaf in shape and veining.

4. *Costus*, in its seedling structure, presents a striking contrast to the nearest related group, the Zingiberoideae. In addition to an unusually strong development of cotyledonary lamina and hypocotyl, two further morphological features fall to be explained: the one, a green spherical outgrowth from the upper surface of the cotyledon where it enters the micropyle of the seed; the other, a ligule arising from the basal end of the cotyledon and similar to that of the adult *Costus* leaf.

5. It is concluded that the adult form of *Costus* expresses

itself in the seedling from the earliest stages, no traces of primitive characters such as are seen in the Zingiberoideae, being therefore observable.

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Flower Colours as Natural Indicators.

By Edith Philip Smith, B.A., Ph.D.

(Read 19th June 1930.)

The colours of flowers can be roughly divided into three groups, according to the nature of the pigments involved. Firstly, the pure rose, crimson (and a few scarlet), magenta, and blue series, which owe their colours to anthocyanins (water-soluble sap-pigments). Secondly, the yellow, orange, brown-red series, due to plastid pigments; and lastly the cases where the two types of pigment exist together and modify the final colour. It is proposed to deal with flowers from the first group only.

The use of extracts from coloured flowers, that is, of anthocyanins, as indicators of acidity and alkalinity is an old one; "Syrup of Violets" is mentioned by Robert Boyle (1) in 1664. The tincture developed a bright cherry-red on addition of acid, and a clear green on the addition of alkali. Such crude and unstable indicators as this watery mixture of anthocyanins find no place in the modern battery of sulphone-phthaleins, etc. However, an attempt has been made to study the reaction of the cell-sap of some coloured flowers by using the plant's own pigment as an "indicator," in solutions of known pH value, and comparing these standards with the colour displayed by the cell-sap in the living petal. Buxton and Darbishire (2) made observations on the reaction of the cell-sap of some flowers, but they used watery extracts of dried flowers and titrated them after various periods. When the extracts were treated immediately, little difference was found between the reaction of red (pH 6) and blue (pH 6·5) flowers. After two to three months, extract of blue flowers had a pH of about 7, and the red about pH 5·5. The flowers used include Delphinium, Viola, Lupin, Rose, Peony. The writers suggest that red flowers have a "selective permeability," admitting the hydrion but excluding potassium ion, etc. The blue flowers are assumed to have lost this selective action, hence their more alkaline reaction. Without entering into this

theoretical discussion, it seems to the present writer that the use of living, unmutilated material for comparison avoids death changes and upsetting of the buffer system of the cells. The solutions used for making the colour-standards are sufficiently well buffered to be unaffected by the plant tissue during the extraction of the pigment.

The writer's attention was first called to this interesting possibility by observing the diurnal colour changes of the short-lived flower of the Morning Glory, *Ipomoea Leerii*. These flowers expand from tightly-rolled, magenta-pink buds to fully-opened pure blue trumpets in a very short time (the exact time depending on the temperature at which they are growing). In a few hours the flower begins to fade, changing through violet back to the original magenta, while the corolla crumples inward and rolls up round the mouth of the tube. Obviously this short period of intense activity is accompanied by a change in the reaction of the cells of the corolla. An attempt was first made to determine the pH value corresponding to the colour-stages of the flower, and then to use this in an examination of the effect of external conditions on the daily rhythm.

Method.

In order to determine the reaction of the corolla cells it was necessary to compare them with a standard. The standard series of colours was prepared by extracting the pigment direct into buffer solutions of various pH values, as follows: 5 c.c. of buffer solution were put in a hard-glass test-tube and warmed in a water-bath. The expanded part of a single corolla was cut off and placed in the buffer. Colour began to diffuse out immediately. The tube was quickly brought to boiling-point and kept boiling ten seconds. On cooling, the tissue was seen to be practically colourless. The coloured liquid was decanted to a fresh tube and sealed. The buffers used for this flower were Palitzsch's boric acid M/5–borax M/20 (Clarke (3), p. 88). Comparisons were made with buffer solution which had been boiled for an hour; also by making an extract of the pigment in water and adding in the cold to the buffer. No appreciable difference could be detected between tubes prepared in this way and by direct extraction, so the simpler method was used in all subsequent experiments. It was found that the pre-

pared tubes kept remarkably well if carefully sealed, but there was no occasion to use old standards when fresh ones were so easily prepared. The comparison of the standard colours with the flower-petal was made by means of Pantin's method (8). A portion of corolla was mounted in water on an ordinary micro-slip with a thin cover-glass. By means of the sub-stage condenser, an image of the standard colour-tubes can be focussed in the plane of the object, and by using the mechanical stage it is easy to bring the cells at the edge of the petal alongside of the standard. By using the untouched petal-edge one can actually examine the cells one by one. The most accurate matching was carried out by dispensing with the microscope mirror. The standards were held in a rack standing on a piece of bristol board, the microscope being mounted on a block so as to permit of direct use of the condenser. To avoid the curvature and refracting edges of the image of a test-tube, use was made of the capillary tubes supplied in the B. D. H. Capillator. Three were used for each tint, mounted side by side.

The same method was used with the other flowers examined, and details of the other buffer-mixtures will be found under the corresponding flowers.

Results with Ipomoea Leerii.

The following were the colours observed in the boric acid : borax buffers.

pH.	Colour.
9·24	green
8·2	green-blue
* 7·8	blue * (full day colour)
7·6	blue-violet
7·3	violet
7·09	red-violet
6·7	red-violet
6·0	magenta (bud-colour and faded corolla).

In M/10 HCl the colour was a bright cherry-red.

The plant under observation was growing in the fernery at the Royal Botanic Garden, Edinburgh. The house is kept

at a day temperature of about 21° C. to 26·7° C. The buds open in the early morning, expanding from the tightly-rolled magenta-pink (pH 6·0) to full blue (pH 7·8) in sixty to ninety minutes. If the sun is shining, the flowers may be over by mid-day, while on a dull day they may last till between 4 and 5 p.m. It was decided to examine the effect of light and temperature on the diurnal changes. To do this it was necessary to use cut flowers, but it was found that buds cut either the night before or at dawn and put in water in the fernery opened quite normally and behaved just like buds of the same day left on the vine. There was therefore no objection on those grounds to using cut flowers in the laboratory. For comparison, measurements were taken of a fully expanded flower, cut at 12.30 p.m. on a dull day, temperature 21° C. (colour pure blue).

Diameter of corolla	9·5 cm.
Length of tube to spring of petals	5·1 ,,
Diameter of tube	1·2 ,,
Distance between ribs at circumference	5·5 ,,

Effect of Light on opening of Buds.—If buds due to open the next day (that is, showing a touch of colour between the ribs of the corolla) are cut and placed in darkness at 12 noon, at a temperature of 18·3° C., they will be open by 9 a.m. next day. The following differences from the normal are seen:—size, less than normal; outline of corolla remains pentagonal, never becomes quite circular; the colour remains deep magenta.

Buds exposed to light from a 60-watt electric bulb, 3 p.m. to 9 a.m., temperature 18·3° C., did not open. The ribs of the corolla unfurled slightly, but no more. The colour remained deep magenta, and the flower withered without opening.

Evidence that exposure to light in the bud influences flower-colour is given by the behaviour of a cluster of buds put to open in darkness. Each successive bud to open is redder in colour than the first, and smaller in size.

Effect of Temperature on opening of Buds.—The effect of different temperatures was tried on buds in darkness only. It was found that between 15° to 32° C. buds would open; above 32° C. the flowers withered in the bud. Increase of temperature increases the speed of the opening and withering;

the whole flowering period is over by 9 a.m. at 32° C. in darkness. It was found that a temperature of 21° C. was the optimum, judging by size of flower and colour of corolla. Even at this temperature the corolla never reached the pure blue of the illuminated flower; a deep violet-blue was the best.

It is evident, therefore, that the full development of the flower is conditioned by both light and temperature, light being the master-factor in determining the reaction of the cell-sap of the corolla and therefore the flower-colour.

The effect of carbon dioxide on the colour-change was also tested. It was found (by enclosing the flower in a large desiccator with soda lime, the desiccator being kept in the greenhouse beside the vine) that the colour-change takes place as usual in CO_2 free air. The colour-change is altered (in the acid direction) in atmosphere with excess CO_2. The flower was put in a small beaker of plain water standing in a desiccator with 500 c.c. of water charged under pressure with CO_2. Cut discs of the corolla are freely permeable to CO_2 over their whole surface, not only at the cut edges. When they are floated on water charged with CO_2 the colour rapidly changes from blue to pink. The CO_2 passes out freely when the discs are removed to plain water, where they quickly resume their original colour. It is therefore suggested that the increased acidity as the flower fades is not due to accumulated respiratory CO_2, but to alterations in the buffer-system of the cells. It has been noted by Irwin (5) that increased respiration in corollas of *Salvia* may be accompanied by decreased acidity, as judged by the colour of the flower.

It is obvious that the metabolic changes accompanying the rapid opening and fading of a flower are exceedingly complicated, and the study of the changing sap-reactions may cast light on some of the angles of the problem.

Primula sinensis.

In turning to the colour varieties of *Primula sinensis* we are dealing with material whose hereditary equipment and genetic behaviour has been extensively studied. Gregory, de Winton, and Bateson (4) have given an account of some of the factors concerned with the production of colour in

the stigma, corolla, calyx, leaves, and stems. These include the following :—

G, giving green stigma ; g, red stigma.
B, blue colour ; b, red.

There is also the factor R, which with B gives magentas.

The flowers studied were " Reading Ruby " (deep magenta, BR), " The Czar " (dark blue, Br), " Etna " (dark red in flowers, stigma, leaves, and stems, bR), and " Light Blue Star." The first observations on these flowers were made in July 1928 at the John Innes Horticultural Institution, on plants from the late Mr. Gregory's strains, carried on by Miss de Winton. The experiments were carried on at University College, Dundee, during the seasons 1929 and 1930, at intervals from March to June. In this case the plants were seedlings from Messrs. Suttons' seeds, in their first year of growth. As the season progressed it was found that the " blue forms " became more purple than during the early months of the year. Whether increasing temperature or light is the cause of this has not yet been ascertained.

The method of extraction of pigment was the same as that used for *Ipomoea*, but because of the small size of the flowers it was necessary to use two corollas to 5 c.c. liquid. In addition to anthocyanins, these flowers contain quantities of flavones, especially in the tube and " eye " of the flower : only the expanded part of the corolla was used for extraction. In order to check the tints assumed by the pigments in different buffers, three sets were prepared :—Palitzsch (3), Clark & Lubs' acid potassium phosphate and sodium hydroxide, [range pH 5·8–8·0] (3), and the British Drug Houses Universal Buffer mixture, pH 2·8–7·2. The borate buffers were not of much use in this case, because the reactions of the flowers proved to lie well on the acid side of neutrality. The colours of the phosphate and the U.B.M. tubes agreed well ; the latter gave a slightly better match with the flower-petal at the acid end of the scale. The corolla of Etna gave a reaction of approximately pH 3·1, of Reading Ruby about 4·0, and of Czar about 4.7.

Comparing the pigments of Etna and Czar, from pH 2·8 to pH 9·24, they appeared to be indistinguishable in tint in solutions of the same pH value. Reading Ruby gave a bluer tint over the significant part of the range.

It is suggested that the pigment of Etna and Czar is the same, and that the factor-difference between them (turning red into blue) is concerned with the reaction of the cell-sap; that is, with the buffer system of the cells. The same pigment in cell-sap of different reactions would show up as a different colour.

The behaviour of Reading Ruby suggests the presence of another anthocyanin along with that occurring in Etna and Czar. Reading Ruby also behaves as a dominant to Etna and Czar.

The pale colour of Light Blue Star made it difficult to prepare standards of a sufficiently deep tint to compare with Etna and Czar, but by diluting pigments from the latter flowers with the appropriate buffers the Light Blue Star could be matched. There again the colour was indistinguishable from those of Etna and Czar. Much flavone was present.

Papaver Rhoeas.

For details of the factorial situation in *Papaver Rhoeas*, see the paper by Newton (6). The plant provides a number of coloured strains, which can be arranged in the following epistatic series: crimson, scarlet, port, claret, mauve. Crimson is heterozygous, and single-factor differences exist between scarlet-port, port-claret, claret-mauve. When tested in buffers the scarlet-port pigments appeared the same. Much flavone is present, especially in black spot at base, which is better removed for test. There again a reaction-regulating function is suggested for a Mendelian factor.

It is natural that in breeding work, especially as methods grow more refined and tests more exacting, attention should be principally focussed on morphological expressions which it is possible to assess with considerable accuracy. The extensive work on inheritance of the more subtle physiological or metabolic characteristics in Maize needs to be extended to many other plants. The work of Small (9) and his co-workers on the hydrion concentration of plant tissues might well be applied most profitably to plants of known genetic constitution and behaviour, and these observations on flower-colour and reaction extended. Many plants exist in which there are full- and pale-coloured, or blue, red and pink varieties; for

example, the Annual Convolvulus (*C. tricolor*), Corn-flower, not to mention Sweet Pea. The greenhouse *Cineraria* is in the act of producing a difficult and interesting problem. The majority of the current florists' strains show blue, violet, magenta, crimson, and rose shades, which might easily be referable to one type of anthocyanin pigment. Recently there have appeared on the market so-called scarlet (really brick-red) strains. The raiser of one of these strains has told the writer that the colour appeared spontaneously in a family of "pink shades." By selection the proportion of brick shades has been increased. The writer is attempting by strict isolation of plants of the brick-red strain to obtain a selfed progeny which will give at least an indication of the diversity of the strain. But the problem remains a chemical one—does the appearance of this new colour indicate a new chemical compound made by the plant (*i.e.* a brick instead of a rose-red anthocyanin): is it a question of sap reaction, or of a development of plastid pigment in addition to sap pigment? If the breeding experiments are successful, it may be possible to attempt an answer to some of these questions, but in the meantime they must be left unanswered.

Summary.

1. The colour of the cell-sap in living cells of the following flowers, *Ipomoea Leerii*, *Primula sinensis*, *Papaver Rhoeas*, was compared with buffer standards prepared with the anthocyanins of the flowers themselves.

2. It was possible in this way to estimate the approximate pH value of the cell-sap corresponding to the colours shown by the flowers under various conditions.

3. *Ipomoea Leerii* has a diurnal colour-range from magenta-pink (bud) to full blue in the freshly-opened flower, corresponding to a pH range of 6–7·8. The development of the full blue is conditioned by both light and temperature. In the dark a violet (pH 7·09–pH 7·3) is the colour attained, between 15°–32° C. At a temperature below 15° C., in light, a similar colour is reached.

4. The commercial colour-varieties "Czar," "Etna," "Reading Ruby," "Light Blue Star" of *Primula sinensis* were examined. The cell-sap of Etna was the most acid (about

pH 3·1), Reading Ruby about 4·0, and Czar about 4·7. The pH value of the Light Blue Star was not determined. The colours obtained from the corollas of Etna and Czar, at the same pH. values in the same buffers, were indistinguishable. It is suggested that the genetic factorial difference between these two flower-colours is one affecting the reaction of the cell-sap of the corolla and possibly of the whole plant.

5. In *Papaver Rhoeas* the two colours "scarlet" and "port" also gave similar tints at the same pH value of the same buffers.

6. The application of this method of investigation to other families where similar colour varieties exist is suggested.

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Notes on Galloway Roses. By J. R. Matthews, M.A.

(Read 19th June 1930.)

Due largely to the work of M'Andrew, Druce, and others, the flora of Galloway may be regarded as now fairly well known. It will always remain an interesting part of the Scottish flora by reason of its peculiar composition, including as it does a considerable proportion of the "Southern Element" of the British flora which finds its way into Scotland. Several lists for the area have been published, and these have been consulted in drawing up the following notes on the roses of the district. Most of the records, however, are based on my own gatherings made during a short visit last August. The rose flora is not abundant, nor are the species widely distributed. In Wigtownshire they are most frequent in the Machars or low-lying cultivated plains in the south, and except in the sheltered valleys are absent from the moors lying on the north side of the county. Throughout the county as a whole there is evidence, as elsewhere in Scotland, that the relative infrequency of roses as members of the native flora is not unconnected with the development of the modern highway, broader roads replacing the former narrow lanes where roses often abounded.

Unless otherwise stated, the records which follow refer to Wigtownshire, v.-c. 74, and many are additional to the vice-comital distribution given by Col. Wolley-Dod in his Revised Arrangement of British Roses. The names used are those of the London Catalogue, Edit. 11.

R. spinosissima Linn.

Both var. *typica* W.-Dod, with glandular hispid peduncles, and var. *pimpinellifolia* (Linn.), with smooth peduncles, are frequent in suitable coastal habitats. The former occurs at Port William, Terally Point, and Port Logan; the latter is abundant at New England Bay, Torrs Warren, and elsewhere on Luce Bay. Both occur also in inland stations along the Water of Luce and on the roadside between Glenluce and

Carscreugh Castle. The length and hispidity of the peduncles vary considerably, the peduncle frequently being hispid only at the base. Examination of a large series of specimens shows a tendency in some to glandular petioles and midribs, thus approaching var. *Ripartii* (Déségl.), but the leaflets are not glandular-biserrate as in that variety. In some specimens the midribs are sparsely pilose.

×R. Sabini Woods.

A single bush in Grennan Plantation, two miles north of Drummore, agrees closely with the descriptions of this, one of the assemblage of hybrids now grouped under *spinosissimae* ×*villosae*. From the characters of the plant itself and the presence of *R. omissa* Déségl. in close proximity to the hybrid, the evidence is in favour of regarding this species as the second parent. *R. Sabini* is recorded also from Monreith by Druce.

R. canina Linn.

var. *lutetiana* Baker. This is the commonest variety of the aggregate *R. canina* Linn. Although Col. Wolley-Dod gives no records for Scotland, it is certainly not rare north of the border. Localities in Wigtownshire are Grennan Plantation, Glenluce Abbey, and near Bargrennan; also Cree Bridge, Larg, and Blackcraig in Kirkcudbrightshire, v.-c. 73.

var. *separabilis* (Déségl.). A single plant near Glenluce Abbey with fairly large, elongate obovoid fruit seems referable to this variety.

var. *flexibilis* (Déségl.). This does not differ much from var. *lutetiana*. A plant near Grennan Plantation approaches Déséglise's description except in the shape of the leaflets, which are acute, not rounded at the apex. Wolley-Dod refers to the same feature in specimens examined by him and states that the variety is not represented typically in Britain.

var. *senticosa* Baker. Near Benfield between Newton Stewart and Glenluce.

var. *insignis* (Déségl. & Rip.). This is the commonest variety, having irregularly serrate leaflets, showing the transition between the Lutetianae and Dumales groups. Frequent between Glenluce and New Luce, Benfield, and Grennan Plantation; also between Cree Bridge and Larg, v.-c. 73.

var. *globularis* (Franch.). Specimens collected near Glen-

luce Abbey agree well with the original description and with Déséglise's notes on this variety.

var. *syntrichostyla* (Rip.). A single specimen collected at the railway bridge near Bishop Burn between Newton Stewart and Wigtown.

var. *dumalis* Bechst. The common *canina* form with fully biserrate leaflets. Glenluce, Glenluce Abbey, and New Luce; also between Cree Bridge and Larg, v.-c. 73.

var. *biserrata* (Mér.). Glenluce and Dunragit.

var. *recognita* Rouy. One specimen collected at Grennan Plantation comes near this variety.

R. DUMETORUM Thuill.

Druce records *R. dumetorum* from Wigtown. As an aggregate the species is much less frequent than the aggregate *R. canina*, and I have no gatherings of var. *typica* W.-Dod. The following varieties occur:—

var. *urbica* Baker. Grennan Plantation; and between Cree Bridge and Larg, v.-c. 73. Druce records this variety from Penninghame.

var. *jactata* (Déségl.). Near Newton Stewart railway station; and several plants between Cree Bridge and Larg, v.-c. 73.

var. *Gabrielis* R. Kell. Between Cree Bridge and Larg, v.-c. 73.

R. GLAUCA Vill.

This species is not uncommon in the district but its distribution is apparently local.

var. *Reuteri* (God.). Several bushes near Benfield. The serration of the leaflets varies, being occasionally irregularly serrate, thus showing a transition to var. *subcristata* Baker. There is little doubt that a more intensive study of the forms of *R. glauca* and *R. coriifolia*, which are essentially northern species, would prove that they could be further segregated, perhaps along the lines followed for *R. canina* and *R. dumetorum*.

var. *subcristata* (Baker). This is the common variety of *R. glauca*. Frequent at railway bridge near Bishop Burn, near Benfield, and along the New Luce road.

var. *stephanocarpa* (Déségl. & Rip.). Collected in one

locality only about three miles west of Newton Stewart on the Glenluce road. The glandular development on the leaflets varies considerably but is sufficiently pronounced to justify the inclusion of this variety in the list.

var. *subcanina* Chr. Forms of *R. glauca* with reflexed sepals, which may be placed under this name, undoubtedly occur in Scotland, although Wolley-Dod does not include it in his account of the Roses of Britain. The variety is reported from Drummore by Druce.

R. CORIIFOLIA Fries.

This aggregate species, so far as I know, has not hitherto been recorded for Wigtownshire, and is apparently very rare.

var. *obovata* (Baker). Near Bargrennan. Undoubtedly one of the Subcoriifoliae group, the sepals reflexed after flowering.

R. MOLLIS Sm.

In considerable abundance on the roadside about midway between Newton Stewart and Glenluce. The presence of subfoliar glands refers the specimen to var. *glandulosa* W.-Dod, but my experience of *R. mollis* in Scotland inclines me to the view that glandularity in this species is of little taxonomic value. Also near Queen Mary's Bridge, Minnigaff, v.-c. 73. Druce records var. *coerulea* Baker from Port Logan. For recent views regarding the classification of the forms of this and other northern species see Heslop Harrison.

R. OMISSA Déségl.

The numerous so-called varieties of this are difficult to distinguish and a new arrangement has been suggested by Heslop Harrison.

var. *typica* R. Kell. and forma *resinosoides* (Crép.) occur near New Luce and at Grennan Plantation; also near Larg, v.-c. 73. Recorded from Drummore by Druce.

var. *Sherardi* (Davies). New Luce.

var. *submollis* (Ley). Grennan Plantation and between Cree Bridge and Larg, v.-c. 73.

var. *pseudo-mollis* E. G. Baker. Near railway station between Newton Stewart and Wigtown.

var. *Woodsiana* (Groves). Near Glenluce, one gathering.

var. *suberecta* (Ley). This is the commonest variety of the *omissa* aggregate. Glenluce, Grennan Plantation, Benfield. Also near Larg, v.-c. 73. Recorded from Dunragit by Druce.

var. *cinerascens* (Dum.). A single bush near Grennan Plantation agrees fairly closely with the technical characters ascribed to this variety, although the leaflets are not perfectly uniserrate.

R. TOMENTOSA Sm.

I have no gathering of this, which I believe to be a comparatively rare species in Scotland, most northern so-called *tomenosa* forms being referable to the *omissa* group. It is recorded from Penninghame (Druce) and from Newton Stewart (Bailey).

R. RUBIGINOSA Linn.

This and its variety *apricorum* (Rip.) are recorded by Druce, who regards the species as native in Galloway.

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A Note on a Rare Parasitic Fungus on Myrica Gale L.—Ovularia destructiva (Phil. & Plow.) Massee.

By C. E. Foister, B.A.

(Read 19th June 1930.)

Specimens of the bog myrtle, *Myrica Gale L.*, were collected at Garelochhead in May by Mrs. N. L. Alcock, and some were found to be affected with a disease which involved the ends of twigs only. These were covered with a thick, greyish-white band, varying from 0·5 cm. to 1·5 cm. in width. The band was found to consist of the fructifications of a fungus, the mycelium of which permeated the bark and vascular tissues in particular. The effect of the attack was a stunting of the twigs. The presence of the causal fungus on the twigs has not been recorded before in Scotland, and it was thought desirable to record this rare occurrence.

The causal fungus, *Ovularia destructiva* (Phil. & Plow.) Massee, forms stromatic cushions under the bark which ultimately burst through, and because these stroma are so closely produced, a band of uniform appearance is the result. Upon the stroma unbranched, fertile hyphae bear oval or elliptical, hyaline, one-celled spores, which average $21{\cdot}5 \times 10{\cdot}6\ \mu$, with a range in measurement of $18{\cdot}3\text{–}24{\cdot}3 \times 7{\cdot}5\text{–}13{\cdot}5\ \mu$. On identifying this fungus as a species of *Ovularia*, comparison was made with a fungus on the leaves of *Myrica Gale* collected by Dr. M. Wilson. The latter fungus causes brown spots on the upper side of the leaves, while on the under side of the leaves, in the same area as the brown spot, a white weft of the mycelium of the fungus is produced. Spores of the latter fungus measured $21{\cdot}2 \times 9{\cdot}9\ \mu$ and were apparently identical in this respect and other characteristics with the fungus on the twigs. While the specimens were kept under examination in a damp chamber, the fungus spread to the leaves and produced on them brown spots similar to those found on the leaves collected by Dr. Wilson.

Ovularia destructiva was first recorded at North Wootton, Lincs., by Phillips and Plowright in 1877, but they named it *Ramularia destructiva*; they recorded it on both leaves and

twigs. Since then the fungus has not been recorded on the twigs in England, and in any case, its record on the twigs in Scotland is believed to be new. In 1885 Ellis and Martin found the same fungus in America, but named it *Ovularia monilioides*; while Peck in Germany recorded it as *Ovularia myricae*. In 1886 Eichelbaum collected it in Hamburg, naming it *Sphaeria Sommeri*; and Saccardo listed it more correctly as *Ovularia Sommeri* (Eichelbaum). It has also been found in Belgium, Holland, Sweden, and Denmark; in the last-mentioned country Lind states that the fungus is very common all the year round. Lind was also the first to correctly and fully name the fungus as *Ovularia destructiva* (Phil. & Plow.) Massee. Vestergren states that the fungus hibernates on the twigs and buds. The damage is not usually severe, stunting being the chief effect.

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The Scottish Alpine Botanical Club Excursion, 1928.

By Robert Moyes Adam. (With Pl. XVI.)

(Read 16th October 1930.)

On the evening of 23rd July the members assembled for their annual excursion at the Invercauld Arms Hotel, Braemar.

The following morning plans were made to examine the region of Little Craigandal and, if the weather proved favourable, to include the massif of Beinn a' Bhuird.

Accordingly, starting out from Braemar by the aid of a horse-gig, the party forded the Dee and reached the grounds of Invercauld, and thereafter proceeded through a forest of Pines as far as vehicular traffic was possible. This brought them to the course of the Sluggan burn, along which a pony-track supplied comparatively easy access to the higher peaks of the Cairngorms. They had purposed at first to confine their attention to Little Craigandal, from which less common Alpines had been reported in 1889 ; but, as the party were in good heart and the prospect was pleasing, they decided to venture farther and attempt Beinn a' Bhuird, on which immense snow-fields still remained.

Making their way thither, and keeping the Quoich water on their left, they soon gained evidence of their rapid ascent in the gathering of *Cornus suecica* L. in flower, and *Betula nana* L. in full leaf. A steady pull to the point where a smaller stream from the base of Beinn A'an joined the Quoich brought them into full view of their objective ; and heading southward over a rough surface bestrewn with *Vaccinium uliginosum* L., they obtained an extensive view of the Dee valley and the mountains to the south and west, of which Lochnagar was the outstanding feature. Visibility being at its best, the contour and colour of that attractive hilltop were seen to perfection.

At something over 2500 feet the moorland became carpeted with Mountain Azalea (*Azalea procumbens* L.), the flowering plants spreading through the herbage, which extended to the barricade of boulders blocking the mouth of the corrie. Going thereafter proved dangerous and exhausting, as only over such improvised stepping-stones could further progress be

made: and the loss of time thereby incurred dissuaded the party from ascending the summit, which to all seeming was bare and uninviting, contenting themselves with searching the screes to the north of Dubh Lochan.

Beinn a' Bhuird, the Table Mountain, is so called, according to a modern writer who has made the range of the Cairngorms his peculiar study, "because the hilltop and its surrounding plateau seem literally flat as a table when viewed from the west." To those approaching it from an opposite direction its flatness did not appear; nor did it prove to possess a flora as varied as others of the same group. Runnels and rock-ledges being anything but plentiful, the chances of the botanists were inevitably lessened; and to add to their difficulties on the present occasion, vegetation was backward and bog-plants hard to distinguish. In this connection it may be of service to put on record that rare Sedges were few and undeveloped, and Alpine Rushes scarce. Search was made for *Saxifraga rivularis* L., reported in 1889 "from the spot where Professor Balfour found it many years ago," but without success. Of plants peculiar to these mountains the Crowfoot (*Ranunculus acris* var. *pumilus* Wahl.) raised its golden cup from swampy patches beneath the screes, its bluntly cut and shining leaves affording it, though lowly, an air of distinction. The common Birch (*Betula alba* L.), which ascended the Sluggan burn to about 2000 feet, bore traces in its cropped and blasted growth of the depredations of Deer and the force of the storms to which it was exposed. In the corrie Stags were viewed at close quarters; but throughout the day Red Grouse were not once flushed.

It was after six o'clock when the party began their journey homeward; and though they availed themselves of the bridle-path all the way down, they did not reach Braemar till after sundown. It has to be explained meanwhile that considerable time was occupied in fording the Dee below Invercauld, an operation which tried to the utmost the jaded botanists, who to maintain a show of fitness on their arrival were not above availing themselves of a passing bus for the last mile and a half! Laborious and long as had been their undertaking, they were able ere retiring to make up the following summary of the day's gatherings, namely: *Thalictrum alpinum* L., *Ranunculus acris* var. *pumilus* Wahl., *Caltha radicans* Forst., *Trollius*

europaeus L., *Cochlearia alpina* Wats., *Silene acaulis* L., *Lychnis dioica* Mill. (at 3000 feet), *Cerastium alpinum* L., *Genista anglica* L., *Rubus saxatilis* L., *R. Chamaemorus* L., *Potentilla Crantzii* G. Beck, *P. Sibbaldi* Hall f., *Saxifraga stellaris* L., *Sedum roseum* Scop., *Epilobium alsinefolium* Vill., *E. alpinum* Huds., *Angelica sylvestris* L., *Cornus suecica* L., *Gnaphalium supinum* L., *Vaccinium uliginosum* L. (marked features of Corrie), *Arctostaphylos Uva-ursi* Spreng., *Azalea procumbens* L., *Pyrola media* Sw., *Trientalis europaea* L. (at 2300 feet), *Veronica alpina* L., *Melampyrum pratense* var. *montanum* Johnst., *Oxyria digyna* Hill, *Betula nana* L., *Salix repens* L., *S. herbacea* L., *Narthecium ossifragum* Huds., *Tofieldia palustris* Huds., *Juncus trifidus* L., *Carex pulicaris* L., *C. canescens* Lightf., *C. rigida* Good., *C. pilulifera* L., *Juniperus communis* L., *Cryptogramme crispa* Br., *Lastraea dilatata* Presl, *Lycopodium Selago* L., *L. annotinum* L., *L. clavatum* L., *L. alpinum* L.

Following the lead of members at their meeting in 1889, the Club devoted Wednesday, 25th July, to an excursion to Loch Kander, on the borders of Angus and Aberdeenshire. The day proved gusty, but not unfavourable for a tramp amid romantic scenery.

Availing themselves of means of locomotion provided by the hotel, they drove up Glen Clunie, and, turning to the left three miles out, they reached Loch Callater, along whose shores lay possible tracks in the direction of the more remote district which was the object of their quest. Both of these were found helpful, but that on the south side gave easier access to the Corrie, though it had to be abandoned as soon as the Loch was left behind. The country transversed thereafter abounded in heather, and its undergrowth was plentifully interspersed with Cloudberry and Orchis.

On gaining the higher level behind which lay Loch Kander, bare of vegetation on its margin and swept by fierce gusts from the gullies which flanked the overhanging cliffs, none could fail to be impressed with the majesty of the scene.

There being very little of botanical interest in the immediate vicinity of the Loch, it was decided to scale the heights of Coire Ceann Mor and Carn an Tuirc, from which such rarities as *Salix Sadleri* and *Carex frigida* had been reported. Three independent routes were selected, and much scrambling called

Coire Dubh and Coire nan Clach, eastern face of Beinn a' Bhuird, 3924 feet.

Coire Ceann Mor, Glen Callater, showing steep rocks descending on the north face of Cairn na Glasha, 3484 feet, to Loch Kander.

Robert Moyes Adam.

for, yet with rather meagre gleanings, the less common Sedges in particular being scarce. As on the previous day, vegetation was found to be backward, many of the true Alpines being only in flower. Another incident, which may account for their apparent infrequence in that particular area, was the discovery of sixty head of goats, of comparatively recent introduction, browsing on precipitous ledges, where sheep and deer do not naturally venture. Yet, in spite of untoward circumstances, a goodly collection of plants was made, and an enjoyable day spent amidst nature's solitude and grandeur, occasional showers and squalls only deepening the impression.

A leisurely walk by the same route followed earlier in the day brought the united party to the northern end of Loch Callater, where a motor-car awaited their return.

Among the specimens secured the following may be named : *Thalictrum alpinum* L., *Ranunculus reptans* L., *Caltha palustris* L., *Cochlearia alpina* Wats., *Silene acaulis* L., *Cerastium alpinum* L., *Geranium sylvaticum* L., *Rubus Chamaemorus* L., *Saxifraga aizoides* L., *S. oppositifolia* L., *S. stellaris* L., *S. hypnoides* L., *Parnassia palustris* L., *Sedum roseum* Scop., *Epilobium alsinefolium* Vill., *E. alpinum* Huds., *Angelica sylvestris* L., *Galium boreale* L., *Gnaphalium supinum* L., *Vaccinium uliginosum* L., *Trientalis europaea* L., *Menyanthes trifoliata* L., *Veronica humifusa* Dicks., *Melampyrum pratense* var. *montanum* Johnst., *Littorella lacustris* L., *Polygonum viviparum* L., *Salix lapponum* L., *S. myrsinites* L., *S. herbacea* L., *S. reticulata* L., *Tofieldia palustris* Huds., *Juncus trifidus* L., *J. supinus* Moench., *J. triglumis* L., *Carex pulicaris* L., *C. atrata* L., *C. rigida* Good., *C. capillaris* L., *C. inflata* Huds., *Alopecurus alpinus* Sm., *Phleum alpinum* L., *Briza media* L., *Poa alpina* L., *Cryptogramme crispa* Br., *Athyrium alpestre* Milde, *Botrychium Lunaria* Sw., *Lycopodium Selago* L., *L. alpinum* L., *L. clavatum* L., *Selaginella selaginoides* Gray.

The Scottish Alpine Botanical Club Excursion, 1929.

By Robert Moyes Adam. (With Pl. XVII.)

(Read 16th October 1930.)

In the evening of 15th July the members of the Club assembled in the dining-room at the Spittal of Glenshee Hotel. The number was fewer than usual. The date of the meeting was shadowed by the death of the oldest member, the Very Rev. Dr. David Paul, and to whom earlier in the day the President and Vice-President had paid their last tribute at the graveside in Edinburgh. It seemed strange to hold the meeting without the veteran, for no more enthusiastic and regular attender at the Annual Excursion had the Club. The Scottish Alpine Flora was near to his heart, and to carry through the arranged programme seemed not unfitting and appropriate.

In the course of a stroll after dinner along the entrance to Glen Lochy members admired the abundance of *Helianthemum Chamaecistus* in excellent state.

Tuesday, 16th July, was devoted to a visitation of the gardens at Balmoral and Glassel House in Deeside. Transport facilities were generously provided by one of the members, and the journey made by the Devil's Elbow and Cairnwell Pass *via* Braemar. This highway afforded a striking example of the improved Highland road. In former times the narrowness, frequent dangerous bends, made the driver's task hazardous—now a new danger has arisen in the frequency and number of vehicles which travel north and south over this roadway. In the course of the Club's run the dryness of the hill slopes was everywhere in evidence. Watercourses were either dry or holding mere trickles. Rainfall over this area had been negligible for months and constituted one of the driest periods on record. A halt was made for a short space in the Scots Pine forest beyond Invercauld where it was believed *Linnaea borealis* might be observed. The search proved unsuccessful, and punctually at noon the party arrived at the Crathie entrance to Balmoral Castle. After receiving directions at the gate, a slow pace for a few hundred yards along the drive brought the party to the residence of the King's Com-

missioner—Major Mackenzie, M.V.O. Thereafter in company with him the nursery was visited, and several interesting exotics were observed in seedling stage. The President noted among them familiar Asiatic species. From the nursery the party proceeded by car to the environs of the Castle, the route followed leading through an avenue of stately Conifers which had been planted and directed in the life of the late Prince Consort some seventy years ago. The sunk garden on the west side of the Castle was visited. It is of recent construction and occupies an area about 600 yards square and is sunk about 4 feet below the general level of the terrace. The garden is walled with granite blocks, which are built so as to provide ledges and crannies for rock-loving plants. On the extreme margin of the Castle lawn to the south is another garden. The design has been cunningly conceived, for the observer who surveys the lawn from the Castle detects no sign of this delightful addition to Balmoral gardens. On a near approach the site and design appear. The whole takes the form of a crescent, with two terraces at different levels, each supported by a wall to face south, over which rock-plants spread or hang from every point. The design is intersected by a paved pathway and steps which connect the different levels. On the boundary next the Forest is a novel hedge of Poplar. A dense herbaceous border flanks the garden on the west. Among the flowers noted, the colours of mauve and yellow strike a dominant note, and the Club was informed that they are among the favourites of their Majesties. It was also pointed out that every effort is made to grow plants which afford a bright display in autumn—the usual time when Royalty are in residence. The Castle gardens are 1100 feet above sea-level, and suffer frequently from frost in every month of the year. The tour of inspection was completed by observing the show of dwarf Rhododendrons which grow near the Commissioner's residence.

After thanking Major Mackenzie for his kindness and courtesy the party left by the Abergeldie road, proceeding *via* Knock and the south side of the Dee, to miss Ballater, and on where the river was crossed at Aboyne. The main Deeside highway was now joined, and thence by Kincardine O'Neil to Torphins, Glassel House was reached shortly after 4 p.m. On the arrival of the party, Mr. Wood, the owner, was found busy

among his plants in the garden, but on hearing that the Club had come, hastened to welcome them.

The Glassel rock garden was found to be of exceptional interest. Most of the design has been fashioned out of a natural rocky declivity which lay south of the mansion, the whole descending sharply towards the Canny burn, a tributary of the Dee. The work of forming the garden has been largely due to the enthusiasm of the owner, who has spared neither time nor expense to perfect his plan. Water is led on to the upper levels, and by an ingenious system of miniature rills and rivulets—which in places link up rock basins, providing a perfect system of habitats, all of which have been used to the best advantage by the gardener. Over all this wonderful rock-work appropriate stone steps are here and there placed so that every point is accessible, while the specimens observed in cultivation were outstanding in their health and vigour. Mr. Wood also gave an exhibition of his Apiary and the appliances employed, and a hut erected for the purpose of instructional courses directed by himself. The afternoon was found to be all too short for the amount to be seen, and about 7.30 the Club had reluctantly to depart after cordially thanking him for his kindness and hospitality. The return journey was made *via* the Moor of Dinnet, where the whole scene was ablaze with the purple of *Erica cinerea*, and then through the Birch forests and the Pass of Ballater to Braemar, and thanks to a careful and efficient chauffeur, Glen Shee was reached at 8.30 p.m.

For the Wednesday the Mecca fixed for the Club's activities was the famous corries in Canlochan Glen, and more particularly the rocky slopes which descend in the east from Glas Maol. Again, as on the previous day, a conveyance to assist the party was provided by the Vice-President. It was shortly after 9 a.m. when the hotel was left behind, and, proceeding by the highway in Glen Beg to a point near Ruidh Doreh, a pause was made to inspect an unusually fine patch of *Mimulus Langsdorffii*. The form was noted to be unlike the ordinary form, having remarkable spotting on the corolla. Joining the car, no further stop was made until the pass was reached, and a few yards beyond the summit the excursion party bade farewell to the Vice-President and his car, and, turning to the right, commenced the gradual ascent towards the county

march fence—a very valuable land guide, incidentally separating the counties of Aberdeen and Perth. Meall Odhar, 3059 feet, is the first summit gained by following the boundary fence, but with a start at the road of 2250 feet, the ascent seemed easy to conquer. Outstanding of the plants were the numbers of *Azalea procumbens* flowering near the top and in a situation where wind action was much in evidence, most of the heath forming low-stunted growth. A dip of a few hundred feet and we were at the base of the gentle slope which in places forms long screes of dry rock and ultimately reaches the broad summit of Glas Maol. Before commencing the ascent several boggy pools were examined, and from several flushes the first real contact with Arctic Alpines was made.

The ascent of Glas Maol was made in zigzag fashion, and in due course the broad top was reached without any remarkable find. The whole summit region is covered with a carpet of vegetation among which *Carex rigida* is dominant. Near to the top also three county boundaries intersect—Perth, Aberdeen, and Forfar.

From the cairn, proceeding in an easterly direction, a descent of 200 feet brought the party to the old and historic track which the weary foot-traveller must use when crossing from Deeside to Glen Isla. The path is the highest of its kind in Scotland, and at the point where it skirts the Canlochan cliffs is 3300 feet above sea-level. Unfortunately this elevated viewpoint did not yield the prospect which in clear weather is impressive. A marked heat haze hung heavily over the great hollow of Canlochan. The Club, however, were in some measure compensated by the fine view of a Golden Eagle as it sailed out from the rocks below, and after a few wide sweeps disappeared into the haze. The botanical investigation began by an approach and descent of the great gully which is drained by a stream at the S.W. of the corrie, and in the course of the preliminary searches proved to be most productive. In a short space a dozen gems of Arctic Alpine fame were seen and a few collected. Outstanding were the masses of *Saxifraga hypnoides* in the most wonderful flower. Near the springs from which the stream was fed *Phleum alpinum* was abundant. *Saxifraga nivalis* was numerous and in flower. On one buttress were beautiful mats of *Dryas*, and a careful hunt alongside revealed numerous plants of that charming Alpine

Gentiana nivalis. Occurring frequently too on the scree were plants of *Veronica saxatilis*, and after raking over the highest position of one of the many stone shoots, a solitary plant of *Thlaspi alpestre* in fruit was picked. Over the dry ledges and cracks occurred many plants of *Erigeron borealis* in beautiful flower. *Saussurea alpina* was abundant but not yet in flower. The rocks were found to hold an infinite variety of habitats, and, in spite of the long period of drought, had very wet ledges where *Carex* dominated and odd plants of *Lychnis dioica* added a splash of colour. Of the Willows, *Salix lapponum* was the most abundant, and in the cooler recesses was very beautiful and in full flower—catkins very numerous. In spite of the riches which the corrie held, one plant failed to reveal itself—*Lactuca alpina*—but as there are many inaccessible ledges abundantly supplied with the conditions favourable to this plant, it may still hold out in this, one of the few localities where the plant has been found. The Club members spent several hours on the rocks and examined with some thoroughness the Glas Maol side, and it was about 6.30 p.m. when the members reassembled at the top of the gully where the first descent of the day had been made.

After exchanging notes on the finds of the day, the party started for home. The route followed was by the S.E. shoulder of Glas Maol, so as to omit the summit, and a diagonal descent towards the col and Meall Odhar, striking at this point a marked track which follows more or less the boundary fence. Holding to this route the road was reached in quick time, and the final stages of the journey were completed by resort to the hotel car, thus bringing to a close a remarkable day.

On 18th July two remaining members carried through a short excursion up Glen Beg and botanised part of the route to Glas Maol. A flying visit to the high tableland the same afternoon by one member, in the hope of collecting *Carex Watsoni*, failed owing to dense mist enveloping the regions about 3000 feet, and after spending some three hours he had to abandon the search. A few plants were added to the list, and the following are the most interesting specimens seen: *Thalictrum alpinum* L., *Trollius europaeus* L., *Cochlearia alpina* Wats., *Thlaspi alpestre* L., *Silene acaulis* L., *Lychnis dioica* Mill., *Cerastium alpinum* L., *Stellaria uliginosa* Murr., *Sagina Linnaei* Presl, *Linum catharticum* L., *Rubus saxatilis*

Eastern cliffs of Glas Maol descending to Canlochan Glen, showing big gully at its south-western end.

OBERT MOYES ADAM.

L., *R. Chamaemorus* L., *Dryas octopetala* L., *Geum rivale* L., *Potentilla Crantzii* G. Beck, *P. Sibbaldi* Hall. f., *Alchemilla alpestris* Schmidt, *A. alpina* L., *Saxifraga oppositifolia* L., *S. nivalis* L., *S. stellaris* L., *S. aizoides* L., *S. hypnoides* L., *Chrysosplenium oppositifolium* L., *C. alternifolium* L., *Parnassia palustris* L., *Epilobium angustifolium* L., *E. alsinefolium* Vill., *E. alpinum* Huds., *E. anagallidifolium* Lam., *Angelica sylvestris* L., *Galium boreale* L., *G. saxatile* L., *Erigeron borealis* Vierh., *Solidago Virgaurea* var. *cambrica* (Huds.), *Gnaphalium supinum* L., *Cnicus heterophyllus* Willd., *Saussurea alpina* DC., *Vaccinium Vitis-Idaea* L., *V. uliginosum* L., *Pyrola secunda* L., *Lysimachia nemorum* L., *Trientalis europaea* L., *Gentiana nivalis* L., *Mimulus Langsdorffii* Donn, *Veronica alpina* L., *V. humifusa* Dicks., *V. saxatilis* L., *Rhinanthus Drummond-Hayi* Druce, *Melampyrum pratense* var. *montanum* Johnst., *Polygonum viviparum* L., *Oxyria digyna* Hill, *Salix lapponum* L., *S. myrsinites* L., *S. herbacea* L., *Habenaria viridis* Br., *Tofieldia palustris* Huds., *Juncus castaneus* Sm., *J. triglumis* L., *Luzula spicata* DC., *Carex pulicaris* L., *C. canescens* Lightf., *C. rigida* Good., *C. atrata* L., *C. Oederi* Retz., *C. capillaris* L., *C. vaginata* Tausch, *Alopecurus alpinus* Sm., *Phleum alpinum* L., *Asplenium viride* Huds., *Athyrium alpestre* Milde, *Polystichum Lonchitis* Roth, *Phegopteris polypodioides* Fée, *P. Dryopteris* Fée, *Botrychium Lunaria* Sw., *Lycopodium Selago* L., *L. alpinum* L., *Selaginella selaginoides* Gray.

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